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BLACK HILLS AREA RESOURCES STUDY

Department of Agriculture
Washington, D. C.

February 1967

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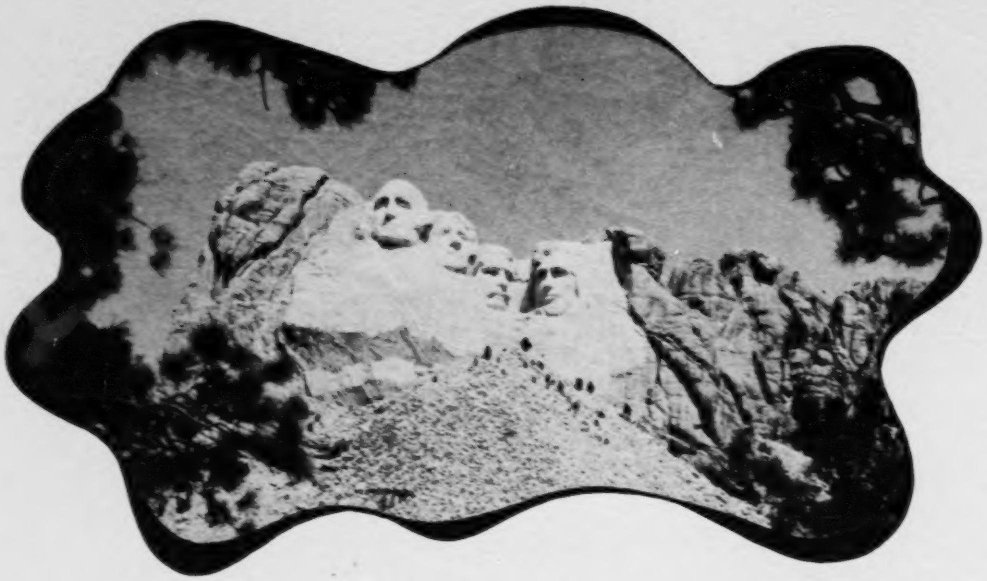

BLACK HILLS AREA
RESOURCES
STUDY

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FEBRUARY 1967

DEPARTMENT
OF AGRICULTURE

DEPARTMENT
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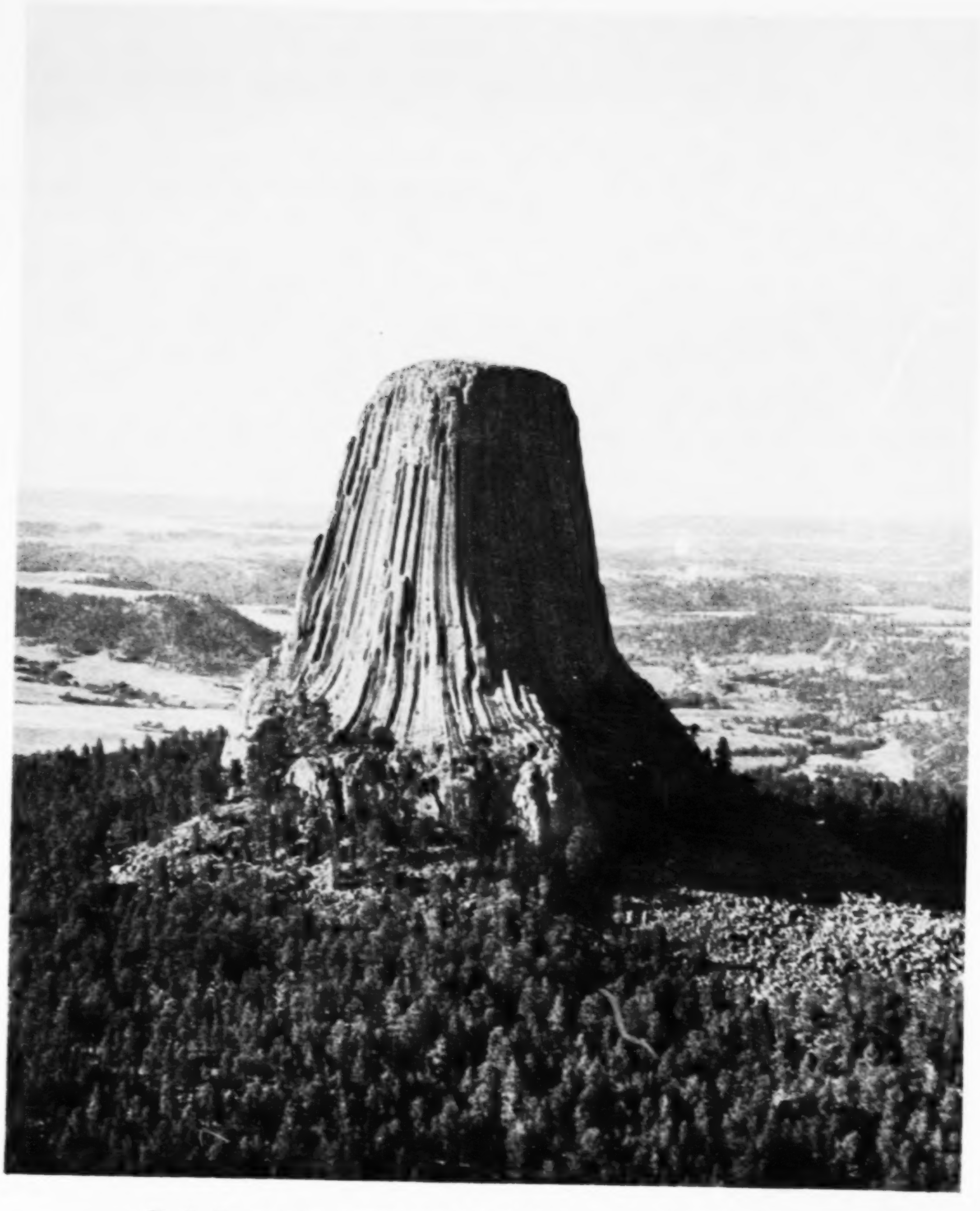

Devils Tower. An outstanding geologic feature of the Black Hills area.

A RESOURCES STUDY

PREPARED BY
THE DEPARTMENTS OF

INTERIOR

BUREAU OF LAND MANAGEMENT
BUREAU OF MINES
BUREAU OF OUTDOOR RECREATION
BUREAU OF RECLAMATION
BUREAU OF SPORT FISHERIES AND WILDLIFE
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GEOLOGICAL SURVEY
NATIONAL PARK SERVICE
BUREAU OF COMMERCIAL FISHERIES
BUREAU OF INDIAN AFFAIRS

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AGRICULTURAL STABILIZATION AND CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
FARMERS HOME ADMINISTRATION
FOREST SERVICE
SOIL CONSERVATION SERVICE

IN COOPERATION WITH THE STATES OF
SOUTH DAKOTA AND WYOMING

ACKNOWLEDGEMENT

The Department of Agriculture and The Department of the Interior gratefully acknowledge the cooperation of the Honorable Nils A. Boe, Governor of South Dakota, and the Honorable Clifford P. Hansen, Governor of Wyoming. Agencies of the two States contributed substantially to this study. The South Dakota Department of Game, Fish and Parks and the Wyoming Game and Fish Commission assigned specific personnel to compile data and secure photographs, thus materially advancing the study.

The Corps of Engineers, Department of the Army, assisted in furnishing information including flood data on flood control and reservoir sites.

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON

February 1, 1967

Honorable Orville L. Freeman
The Secretary of Agriculture

Honorable Stewart L. Udall
The Secretary of the Interior

Dear Secretaries Freeman and Udall:

In July and August of 1965, Senators George McGovern and Gale McGee asked the Departments of Agriculture and Interior to make a broad study of the resources potential of the Black Hills region.

Rich in western history and Indian lore, the Black Hills lie in all or part of six western counties of South Dakota and three in Wyoming. They are characterized by unique areas of rugged, heavily weathered mountains, wild canyons, dark pine-covered hills, and numerous small streams. For years, the area has been a popular playground of the upper midwest.

You assigned to us the responsibility for organizing a task force of resource management specialists to conduct the study and prepare a report. This has now been accomplished. A copy of the report is enclosed for your information. This report is the result of more than a year's closely corrdinated work between representatives of 14 bureaus and offices in both Departments.

Our primary objective from the outset was to develop an up-to-date analysis of the area's resources and some measure of their potential economic value. Such a report we believed would be most useful to local people and their leaders, as a basis for future planning and decision-making. The report accomplishes this objective.

We should quickly add, however, that we have not attempted to provide final, concise answers to complex resource management problems. Our purpose was mainly to identify and analyze. In this process, certain things became evident. We can, for example, draw the following conclusions:

Tourism is the region's principal industry, promising to become even more important in the future. It has little prospect of achieving its full potential however, unless a carefully planned program of full resource development is undertaken.

Water resource management, including preservation and improvement of water quality, urgently needs immediate attention.

Strengthening of the farm-ranch contribution to the economy, including recreation and water supply, should be emphasized in any program concerned with more effective use of the resource base.

Protection of the region's unique recreational values would be considerably enhanced through better land management and the zoning of recreation areas.

In keeping with national trends, the social and economic structure of the Black Hills is changing from rural to urban in character, with the familiar problems of transition.

Some subject matter should be explored in greater depth to provide a sounder base on which to make future resource management decisions.

These and other findings of the task force study suggest the desirability of Federal leadership in seeking solutions to resource-based problems, or guiding certain aspects of planning and development. If the decision is to undertake such action, we would recommend implementation of the following four steps as a sound, logical phase II part of an over-all program:

1. Establishment of a recreation advisory council to guide development of the region's recreation resource. The council should include representatives of Federal and State agencies with major recreation responsibilities, commercial recreation interests, business and civic leadership of the area. Special attention should be focused on ways and means of maintaining and improving the quality of the recreation environment -- such as zoning, landownership and management.

2. Establishment of a watershed management sub-task force to develop a fully coordinated program of land and resource management which will optimize the water yield. Both State and appropriate Federal agencies should be represented, operating under a broad charter. It should conduct investigations in sufficient depth and scope to design a phased action program of resource development, to improve the quantity, timing and quality of water yields from tributary watersheds. One important goal of this assignment should be to increase the capacity of ranch lands to handle peak flows and still reduce sediment yields.

3. Establishment of a sub-task force to determine hydrologic characteristics and the availability of water. This analysis should include a complete study of the so-called "sink-hole" losses with particular emphasis on (a) the desirability and feasibility of increasing surface flows by treatment of the "sink-hole" areas and (b) the extent, if any, and potential threat of underground aquifer pollution associated with the "sink-hole" problem.

4. Establishment of a sub-task force to study in depth the opportunity for a rural area's development program, with primary emphasis on an expanded and diversified manufacturing and agricultural program. Its objective should be twofold:

    (a) To increase opportunities for employment and economic returns from agricultural and forested lands, and

    (b) To explore the feasibility of attracting industrial plants for local processing of area mineral, forest and agricultural resources, so as to provide employment opportunities -- particularly during the non-recreation season.

We further recommend that the foregoing sub-task force and advisory council work be coordinated and carried out under the existing task force structure, and that the State agencies and local entities be accorded their rightful and appropriate roles.

We wish to commend our field task force leaders -- Harold Mosbaugh and Kenneth Scholz -- and representatives of the various Federal agencies, all of whom diligently worked to complete this study, while at the same time carrying the full load of their regular duties and responsibilities. We also wish to acknowledge the significant contributions of several State agencies in both South Dakota and Wyoming, and Governor Nils Boe and Governor Clifford Hansen for their interest and cooperation.

We recommend that you approve and adopt this report and that it be transmitted to Senator McGovern and Senator McGee.

Sincerely,

John A Baker

John A. Baker, Assistant Secretary - Agriculture

Kenneth Holum, Assistant Secretary - Interior

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

FEB 1 1967

Dear Senators McGovern and McGee:

In the summer of 1965 you asked that a joint Agriculture-Interior Department study be made of resource development opportunities in the Black Hills area of South Dakota and Wyoming. You persuaded us that it was a worthwhile undertaking in the national, regional and local interest.

A special task force comprised of bureau representatives from both Departments was appointed immediately thereafter and given their assignments. They have completed the study and a report on their findings. A copy entitled "Black Hills Area Resources Survey" is attached for your information. In addition a joint memorandum by Assistant Secretaries Kenneth Holum and John Baker, from our two Departments, is also attached to the report. You should find their summary of conclusions and recommendations useful to you and your constituents in analyzing the task force report.

This study has been a fruitful, collaborative experience for our two Departments and the bureaus involved. The report deals directly with land, water, minerals, forests and recreation potentials and provides an up-to-date compendium of facts and data on the area's natural resource capabilities and future possibilities.

This document, we believe, will prove to be of infinite value to you, to state officials and local people in measuring the full potential of the unique Black Hills area and in deciding further courses of action.

We are pleased to transmit this report to you and stand ready to assist you in providing further information as may be desired.

Sincerely yours,

Secretary of the Interior

Orville L Freeman

Secretary of Agriculture

Hon. George McGovern
United States Senate
Washington, D. C. 20510

Hon. Gale W. McGee
United States Senate
Washington, D. C. 20510

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INTRODUCTION

This study was approved by the Secretaries of the Departments of the Interior and Agriculture in response to requests from United States Senators George McGovern of South Dakota and Gale McGee of Wyoming.

The original request called attention to severe and longstanding flood and water supply problems in the basins of the Cheyenne and Belle Fourche Rivers in the Black Hills area. It was suggested that studies be coordinated with the other Federal departments and State agencies.

of South Dakota and Wyoming.

After thorough discussion at the Federal, State, and local levels, it was agreed that a joint Interior-Agriculture study would be undertaken and would include those portions of the Cheyenne and Belle Fourche River Basins in South Dakota and Wyoming, an area of approximately 20,000 square miles, including the nine counties of Butte, Lawrence, Meade, Custer, Pennington, and Fall River in South Dakota, and Crook, Weston, and Niobrara in Wyoming.

The primary objective of the study was to examine the long-range needs and potentials of the area and determine whether some further development or management of the natural resource base might serve to reinforce the economy and insure the greater productivity in the public interest. The scope of the study was to include all natural resources, particularly the land, water, agriculture, minerals, timber, recreation, and fish and wildlife. This study does not include detailed economic analyses of the area nor projections of economic impacts resulting from development of the natural resources.

Before work actually began on the study, public meetings were held to familiarize residents of the area with the work proposed and to obtain State and local participation.

SUMMARY AND RECOMMENDATIONS

SUMMARY AND RECOMMENDATIONS

Summary

The economy of the Black Hills area originally was founded on mining, agriculture, and lumbering. These continue to be bulwarks of the area's economy, but circumstances, either inside or outside the area, have limited the expansion potential in each of these fields.

The booming tourist industry, although relatively new as a major economic force, has become the number one income producer in the area and seems to have very substantial potential for expansion. Its future seems brighter than that of any other segment of the area's economy.

In the beginning, it was mineral wealth, particularly gold, that attracted white settlers to the area that had for so long served only as a source of poles for lodges of the Sioux and as the home of their medicine gods. Pay dirt in ever-increasing quantity brought more and more people and from the forests they cut fuel and the rough lumber for their homes, towns, and mines. Soon the miners' demands for fresh produce made agriculture a paying proposition, and thus began three of the important industries upon which the area's economy rests today—agriculture, mining, and timber.

Approximately 83 percent of the land in the study area is in farms; however, agriculture contributes only about 8 percent of the area's total personal income. The 1959 agricultural census showed 4,242 farms, with cash farm sales amounting to about $50 million and jobs for nearly 6,000 people. In 1964 the value of mineral production was $74,663,000; and the industry provided employment for about 2,450 persons. Since the discovery of gold in 1876, mineral production has provided a base for industries that have been mainstays of the economy of the area. The contributions of the timber industry also have been impressive in the Black Hills. In 1964 it provided about 790 man-years of employment, a payroll of about $3,850,000 and contributed some $6.5 million to the economy.

These are producing functions. They provide goods for sale in the form of lumber, foodstuff, minerals, and the like. However, the number one growth industry in the Black Hills is the recreation and tourist industry, which includes hunting and fishing. It produces no goods and exports none; in fact, it imports most of its own consumers. In 1964 nearly three million tourists spent about $75 million in the area. Sportsmen's expenditures for fishing and hunting are estimated to average about $5 million annually.

Not only does the recreation industry export nothing in the form of goods, but it takes little from the natural resource base and demands little for its continued growth except conservation and wise use of this base. It is fortunate that good forest management, for example, incorporating the protection of the forest and the watershed, the harvesting of mature merchantable timber, the production of clear water, and the maintenance of a suitable habitat for fish and wildlife, is characteristic of the very best type of recreation management. It is the forest and its clear sparkling streams, its quiet, and its wildlife that the recreationist seeks. Although he may not be interested in the lumber-producing capacity of the trees, he is vitally interested in the forest and its other attributes.

The Black Hills has come to be a nationally known recreation area. It offers outstanding forests, majestic mountain peaks, amazingly rugged and twisted rock formations, tumbling streams, deep blue lakes, unique caves, a wide variety of wildlife, good fishing opportunities, and over all a refreshing summer climate. Here recreation use and development tend to be concentrated in a compact forested region some 40 miles wide and 85 miles long in the heart of the Hills where topography is unique. It is estimated that the tremendously increased recreation use foreseen for the year 2000 and beyond can be absorbed in relatively small portions of the scenic timbered reaches of the Hills without damage to the resources or the sacrifice of any wise or prudent development of the companion industries upon which much of the economy of the Black Hills area is based. In fact, every reasonable step should be taken not only to lengthen the tourist and recreation season, but to develop other industries to provide a balanced and healthy overall economic structure.

Because of the importance of the recreation industry to the area, both now and in the future, it seems elementary that any development contemplated in the Black Hills area should be planned in consideration of its effect on the resource base. This is vital not only to the recreation industry but the continued well-being of all the resource-oriented industries that now make up so much of the economic backbone of the area. For example, there are deposits of bog iron, taconite, and other minerals in the Black Hills. Methods of mining and processing the iron ores can and should be developed together with means of maintaining the quality of stream environment. The continuance and enhancement of the recreation potential should not and need not preclude or even deter development in other fields. All the side effects of each development should be identified and the deleterious effects minimized or eliminated before the development starts.

The difference between the level of society's demand for goods and services and the level of availability of those goods and services represents the need. The need is great for goods and services that can be supplied by the resource base in the Black Hills area.

It is anticipated that the total population of the Black Hills area will grow from about 128,000 in 1960 to roughly 350,000 by 2020. That expansion likely will be characterized by a commensurate increase in urban population, a much lesser increase in the rural nonfarm population and a loss in the rural farm population.

As the population increases, demands for agricultural production also will increase. It is estimated that needs will increase from 2 to 6 times in various basic agricultural products.

Historically, in the field of timber production, a wide gap has existed between timber growth and utilization; in fact, nearly one-third of the allowable cut remains unutilized today. It is anticipated, however, that the use of timber and wood products will increase over the years. By 2000, the consumption of soft wood is expected to double. However, the most pressing need almost surely will be that the forest itself be kept in a well-managed productive state. A producing forest is a healthy forest. It provides ideal wildlife habitat, water production capability, scenic attractiveness, and the many less obvious values.

Since the first discovery of gold in the Black Hills, the area has yielded a significant flow of metals, nonmetals, and mineral fuels—all essential to the security and the industrial strength of the Nation.

There is every reason to suppose that this national need will continue to support a steady and growing demand for Black Hills mineral production. Current prices for mineral products, as balanced against production and shipping costs, are perhaps the main deterrents to immediate expansion. Major mineral products, in order of value, are petroleum, gold, bentonite, cement, stone, uranium, and sand and gravel.

It is in the field of recreation and tourism, including hunting and fishing, that the greatest need, as represented by the unfulfilled demand for this experience, seems to appear. In terms of total number of visitors expected, the increase is great—from 3,000,000 in 1965 to 10,900,000 in 2020. On the basis of current expenditures, this means a total annual income of from $250 million to $300 million. Even more impressive is a projection of future needs for recreation development shown as percentage increases required in facilities and/or opportunities. Camping, for example, is expected to show a 600 percent increase by 2020, with swimming increasing by 550 percent and water skiing increasing by nearly 700 percent during the same period. Fishing is expected to increase by 350 percent in 1980 and boating to increase more than 400 percent by 2000. It should be noted in this connection that the greatest increases in needs will be in water-based sports—swimming, fishing, boating, and water skiing—and it is in this area that the potential is the most meager.

Although hunting and fishing are usually considered to be a part of the overall outdoor recreation picture, to a dyed-in-the-wool hunter or fisherman there is no other form of recreation. The demand for hunting and fishing is extremely difficult to measure accurately because it is tied closely to the quality of the experience. The best figures available indicate that demands for fishing will increase from an estimated 300,000 man-days in 1960 to 1,529,000 man-days in 2020. The anticipated increase in hunting demand is from 206,000 man-days in

1960 to 500,000 man-days in 2020. In line with the great numbers of out-of-state recreation seekers in the Black Hills, the nonresident plays a significant part in Black Hills hunting and fishing. In the last five years, about two fishermen in five were nonresidents and one hunter in four was a nonresident.

In the Black Hills area, perhaps more than in most places, the ability to produce goods and services depends on the condition of the elemental resources of climate, land, and water. In the Black Hills area, probably more than in most places, it is essential that the land and water resources be conserved and protected from abuse. This is not to say that they should not be used, but it does mean that soil conservation measures are necessary and watershed treatment must continue. It means that the nearly 240 miles of seriously polluted streams in the area should be renovated and that steps should be taken to prevent any further pollution. It means that flood waters and excess flows should be conserved and used beneficially, because water is in extremely short supply. It means also that roads, bridges, and other essential structures should be planned and integrated, and "open space" areas should be preserved through zoning and long-range planning.

It is anticipated that presently producing agricultural and timber land will shrink gradually in the face of the slow but inexorable growth demands of cities, highways, recreation areas, and powerline construction. There is a need to protect and use fully the land that is available. Food requirements indicate that by 2020 production of most commodities must be increased 2 to 6 times. Advanced technology will meet a substantial part of the increased need. A part of the added production can come from grassland converted to cropland and from some additional irrigation.

There will be a need for additional recreation land as the expected increase in recreation seekers materializes. Needs for developed recreation land are expected to more than double by the year 2000 and increase nearly four times by 2020. In terms of acres, the greatest needs will be for extensively used lands for hiking, riding, hunting, and sightseeing. In terms of percentage increase, however, the greatest and most significant needs will be for intensively developed lands for camping, picnicking, water sports facilities, and even some sightseeing.

Most of the agencies exercising control over wildlife resources believe that the land presently in public ownership generally is adequate to provide fish and wildlife resources for the foreseeable future. There is a need, however, to acquire small tracts of private land or easement rights to provide big game wintering areas and public access for hunting and fishing.

The need for developing additional sources of water for population centers is an important one. Projected demand based on an extrapolation of 1966 water use data indicates that by 1980 the total municipal and industrial water requirements will more than double, and by the year

2020 it will be five times the present usage. Further, the need for water for recreation purposes is expected to triple by the year 2000 and increase about five times by the year 2020.

Additional studies of rainfall, runoff, evaporation, and transpiration are needed to determine the practicability and most favorable sites for additional reservoirs to provide needed surface supplies. No data are available for estimating the volume of ground water resources in the area, but they are believed to be considerably in excess of the present rate of use.

Additional development is needed to utilize fully the water resources. Present irrigation storage is being used to the maximum extent feasible with current irrigation practices and present efficiencies of use. Development of substantial irrigation acreage would require large reservoirs capable of impounding flood flows. Surplus flows of most streams are relatively small and reservoirs having comparatively large carryover capacities would be necessary to conserve a significant part of the flood flows for irrigation use.

It is estimated that the population of the study area will triple between 1965 and 2020, and that the number of recreationists in the area will increase more than three and a half times. It will be necessary to increase agricultural production from 2 to 6 times on a steadily shrinking agricultural land base, and to increase recreational lands by about four times by the year 2020.

All of this is possible through renovation or reclamation, conservation, and wise use of the area's natural resources—it is possible, but only with planning, particularly insofar as water is concerned. Water is needed for municipal and industrial growth, for recreation, for fish and wildlife, and for irrigation. These needs are current and they will become critical very soon. However, knowledge of the water supplies in the Black Hills is very limited.

For years agricultural production has been increasing steadily due primarily to new discoveries and new technology. From 1910 to 1950 agricultural output increased approximately 75 percent. It is estimated that wheat yields in the Western States have increased one bushel per acre every 10 years. This trend will undoubtedly continue with new crop varieties, improved management and cultural practices, the use of commercial fertilizers, and irrigation of new land offering the principal methods of increasing crop yields. The best estimates indicate that by 1980 most crops will show a yield increase of 15 to 20 percent and by 2020 yields will increase from 40 to 50 percent. In addition, although the potential for additional irrigation in the study area is not large, some arable land does exist and can be irrigated if water is available.

Even with the increase in crop production forecast, however, it is obvious that the area will not be able to produce all the agricultural produce it needs. It will continue to provide an import market.

Because such a large portion of the timberlands in the area is under the management of Federal and State agencies, adequate multipurpose management practices are available and are presently in effect. It is true that manipulation of the timber cover has a direct effect on the quality and quantity of the streamflow, the production of wood fiber, and the fish and wildlife populations. It also influences the grazing of domestic stock and it is an important factor in the recreation industry. Under multiple-use management, no single resource use is permitted to flourish to the exclusion of the others. Compromise is necessary to make maximum resource use possible. Current efforts are being directed primarily toward improving growth and quality of the timber stands, but greater emphasis must be placed on better utilization and marketing of the forest products.

In the minerals industry, too, marketability is the succinct story of the industry's potential. Minerals abound in the Black Hills. Reserves of such commodities as bentonite, rock, common clay and shale, iron, gypsum, and sand and gravel are abundant, and expanded production awaits only new uses or the expansion of present markets. There are limited known reserves of minerals such as gold, the pegmatite minerals, uranium, and ceramic-grade clay, but experience has shown that exploration will yield new discoveries when economic conditions warrant or when more efficient extraction methods are developed. Then there are minerals such as silver, lead, zinc, tin, molybdenum, and vanadium which have been produced, but for which, at the level of present knowledge, the prospect for greatly increased production is not bright.

Fears have been expressed that future development of the iron ores in the Black Hills may interfere with one or more of the other land and water uses. For the most part, however, mining is now compatible with modern multiple-use concepts of land utilization. Grazing, timber production, and recreation are practical on virtually all land held for mining purposes. With adequate planning, this pattern can continue in the future.

Of the five groups of iron deposits discussed in section V, only two are of prime interest in the foreseeable future—bog iron and taconite. The others, because of their scattered nature, small individual size, or location, pose no particular problem when and if they are developed.

Because it is replenishable, bog iron is unique among mineral deposits. It is forming today and will continue to do so indefinitely, as long as shallow ground water continues to leach iron from the pyrite and pyrrhotite-rich black slates and schists that crop out immediately upstream from areas where the iron is being precipitated in Rapid Creek and its tributaries. This leaching creates natural conditions which are inimical to fish life. Past mining of bog iron also has been injurious to the streams and to the life within them because of silting and chemical changes that occur in the creek water. Some excellent research has been done; the problem and its causes have been isolated. A simple method of mining should be developed in conformance with State water requirements.

Development of the huge tonnage of taconite seems inevitable. Known deposits lie almost entirely within the Boxelder Creek drainage, which localizes problems of water quality. So far as is now known, from studying surface outcrops and results of deep core drilling, these ores are all oxides of iron. There are no sulfides, and the problems associated with acid mine waters, so common in mining sulfide ore bodies, or coals, do not exist. Because the ore bodies are steeply inclined to vertical, excavations will be narrow, and much of the mining will be underground. The surface area affected will be minimal.

The potential for future growth of the recreation and tourism industry is bright indeed; in fact, it would undoubtedly grow and prosper even if there were no attempt to emphasize it. Development will be, however, greater and more efficient if it is planned and centered on the needs of people and the greatest potentials of the area. The greatest opportunities appear to be in land-based recreation, and while most water-based opportunities will be somewhat limited, those that can, should be developed to supplement and complete the recreation offering.

Virtually limitless is the potential for sightseeing, camping, picnicking, swimming, hiking, and riding. First-class lodges, resorts, and dude ranches also present an important future development opportunity. Fishing could be significant, but it is dependent upon an essential improvement and expansion of cold-water fisheries through the utilization of available water supplies and the renovation of polluted trout streams. Winter sports opportunities are limited. Facilities should be expanded, but the nonresident use most likely will be limited.

The main limiting factor in the recreation picture doubtless will be water. Future supplies will be short and with competing demands for municipal, industrial, agricultural, and other needs, it is obvious that recreationists must share water supplies with other users. Multipurpose use is practical and is being emphasized. It is essential, however, that all flowing and stored waters be clear, clean, and used to their full potential, and that recreation use of water be recognized as a legitimate and important use commensurate with the industry's importance to the general economy.

It is apparent that all major segments of the Black Hills economy depend on and use the same basic resources—land and water. In some cases, these have been, and may continue to be, competing uses. If the forest resource is managed strictly for timber production, water and fish and wildlife production and recreation use will likely suffer. If the land area is operated strictly for the benefit of the mining interests, stream pollution, abandoned prospect holes and mine shafts are likely to result. If the area's recreation potential, including the propagation of fish and wildlife, is exploited, other uses will be restricted. The answer is obvious—now and in the future—true multiple use must be practiced; and if a choice must be made, the greatest good for the greatest number must prevail.

Recommendations

The recommendations which follow are based on conclusions set forth in section V. In some cases, effective programs are already in effect and should be accelerated. In others, a shift in emphasis, some coordination, or new programs will be required.

1. All of the significant elements of the Black Hills economy are based on the area's natural resources, the most important of which is water. Because the availability of water of adequate quality is vital to the further development of the Black Hills and since the present state of knowledge of that basic resource is inadequate, it is recommended that immediate steps be taken to:

   a. Alleviate present pollution in the surface waters of the area. Develop and implement a comprehensive water pollution control program through the cooperative efforts of local, State, and Federal agencies to assure satisfactory water quality for all legitimate water uses.

   b. Complete a comprehensive hydrologic study of a selected tributary drainage basin in the Black Hills, including evaporation, interception, and transpiration as well as streamflow, sinkhole losses, and ground water movement.

   c. Install stream-gaging and precipitation stations on all major tributaries to determine water yields from the central crystalline rock area. Additional stream-gaging stations should be installed on selected streams to determine water gains and losses.

   d. Complete investigations to determine the quality and quantity of water available in counties within the area adjacent to the Black Hills and to determine the hydrologic characteristics of the deep aquifers which underlie the counties.

   e. Investigate all potential reservoir sites.

   f. Expand research on weather modification and watershed problems.

2. Because of the need for increased diversity in the economy of the Black Hills area, it is recommended that development and/or marketing studies be undertaken in the following fields:

a. Local processing of crops and livestock.

b. Local processing of wood fiber products including:

(1) Local plywood manufacturing
(2) Increased local sawmilling capacity
(3) Increased commercial pulping
(4) Increased post and pole capacity

c. Development of satisfactory taconite and bog iron mining methods.

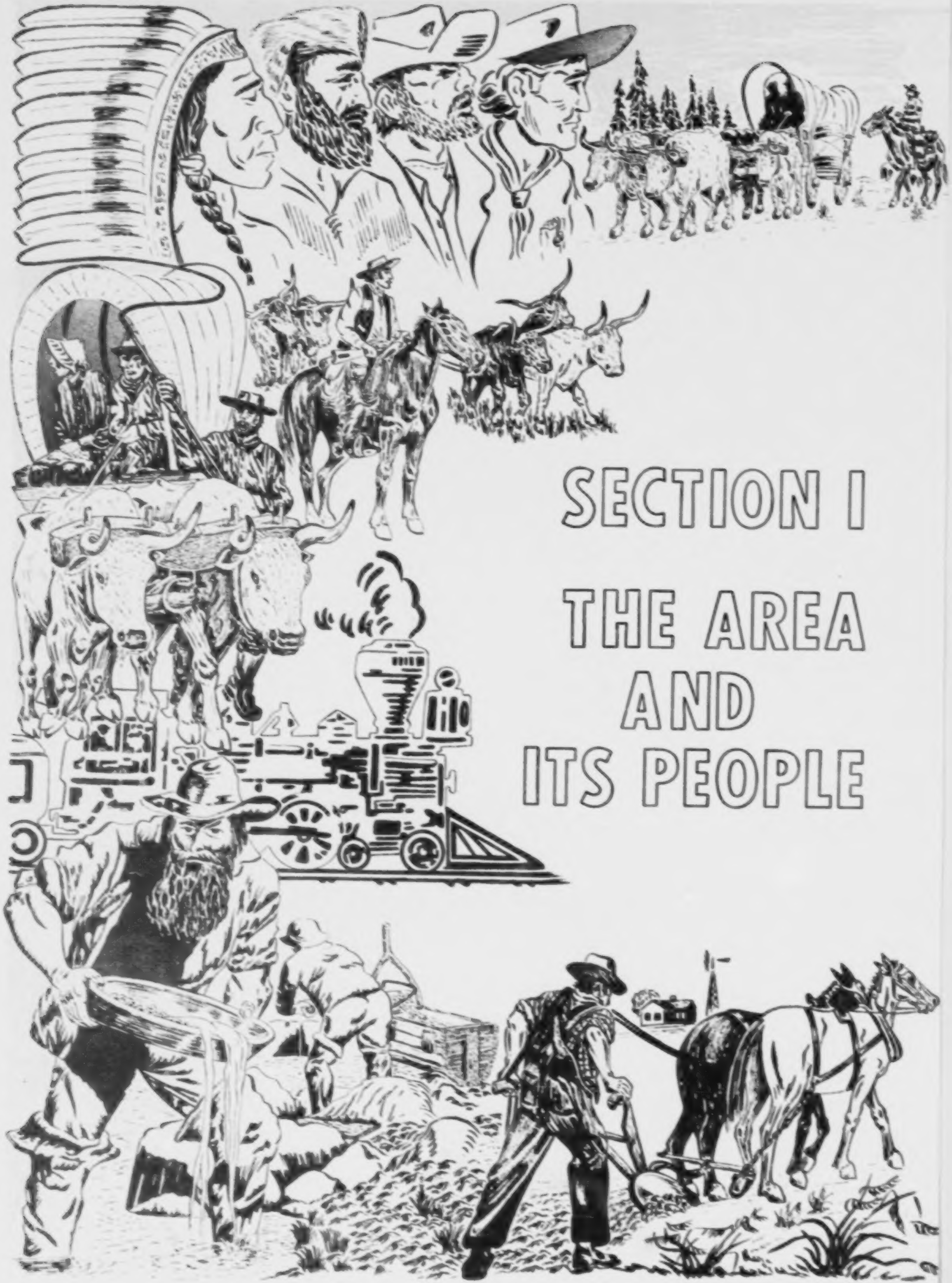
d. Development of economic process for upgrading nonswelling bentonites.

e. Development of new uses and expansion of markets for minerals, particularly bentonite, common clay and shale, gypsum, rock, and sand and gravel.

f. Development of more efficient mining and extraction methods for such commodities as gold, uranium, ceramic-grade clay, and the pegmatite minerals.

3. Because of the growing demands that an expanding economy will place on the area's resources, adequate areawide planning and management in both the private and the public sector will become increasingly important. Therefore, it is recommended that an area coordinating council be established and maintained for the purpose of promoting planning and good management practices throughout the area. The council should include representation from private, State, and Federal interests, and recognizing the area's needs and potentials, promote areawide resources management that will provide the greatest good for the area and the Nation.

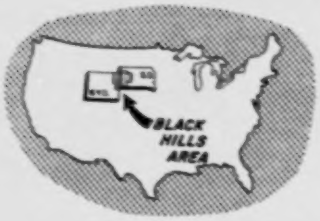
4. The past success and great potential of the area's recreation industry indicate recreation, including hunting and fishing, and tourism should be recognized as one of the most suitable activities for improving and maintaining the area's economy. The future development of the recreation resource should be coordinated and planned on a long-range areawide basis. It is recommended, therefore, that an area coordinating council provide guidance in achieving this objective.



SECTION I

THE AREA AND ITS PEOPLE

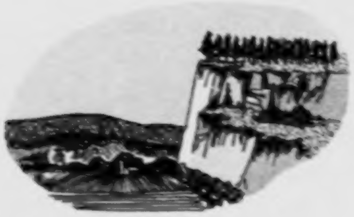
THE AREA AND ITS PEOPLE



LOCATION AND EXTENT

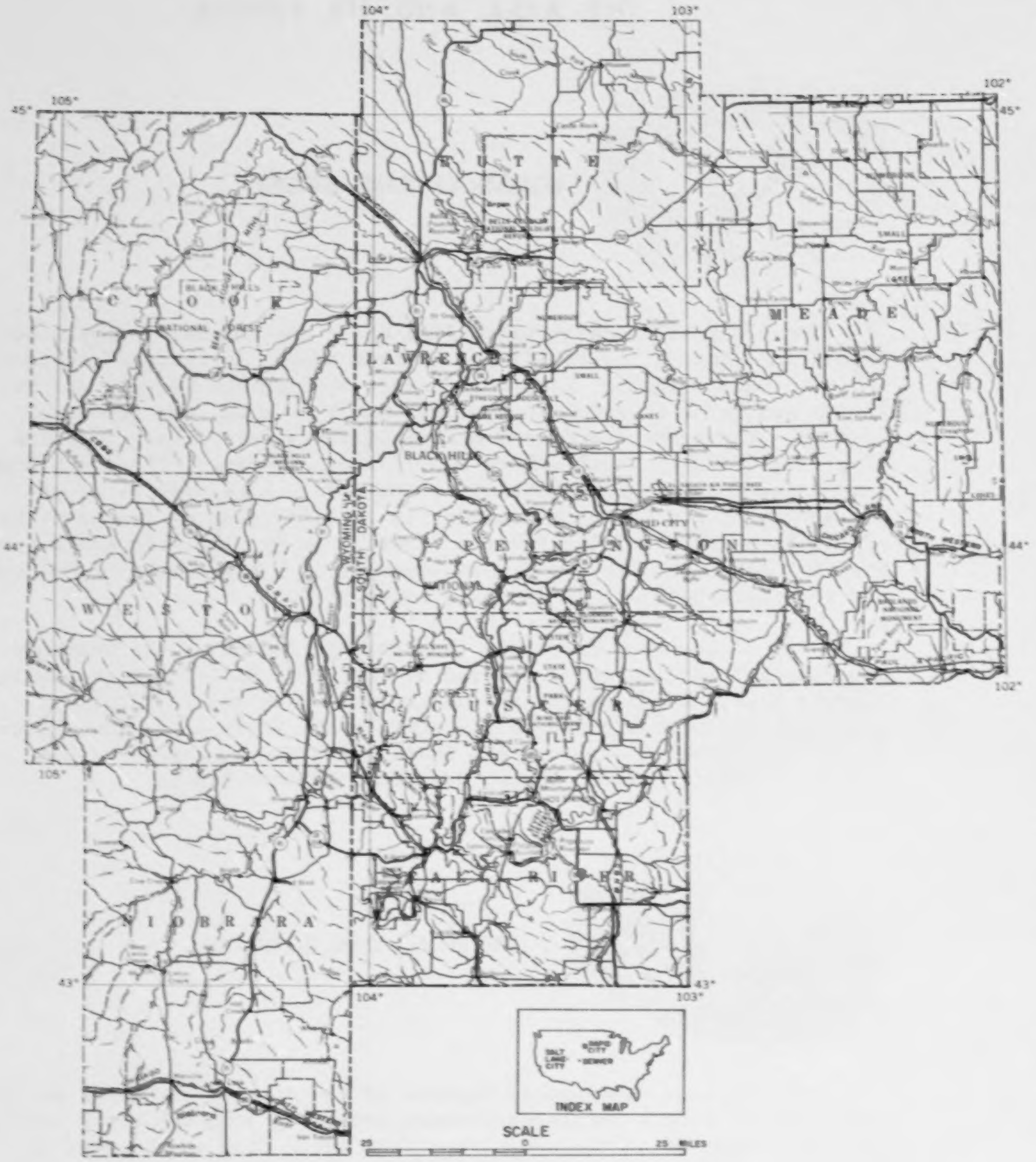
The Black Hills area, which lies along the boundary between South Dakota and Wyoming, is considered in this report to include six counties in South Dakota (Butte, Lawrence, Meade, Pennington, Custer, and Fall River) and three counties in Wyoming (Crook, Weston, and Niobrara) (map 1). The area encompasses nearly 20,600 square miles, of which about 12,700 is in South Dakota and 7,900 in Wyoming. The South Dakota part extends from the Nebraska line north to the headwaters of the Moreau River, and its east boundary is 15 miles east of the junction of the Cheyenne and Belle Fourche Rivers. In Wyoming, the north boundary is the Montana line, the west boundary is 7 miles west of Moorcroft, and the south boundary is 10 miles south of Lusk.

Most of the area is within the drainage basins of the Cheyenne River, which circles the south end of the Black Hills, and the Belle Fourche River, which skirts the north end. Only small tributary drainages of these two rivers lie outside the study area. Outskirts of the area studied also contain small parts of the basins of the Little Missouri, Moreau, White, Bad, and Niobrara Rivers.



PHYSICAL DESCRIPTION

The dominant topographic feature of the area is the Black Hills, which is hilly to mountainous terrain extending from Spearfish on the north to Edgemont on the south, and from Rapid City on the east to Newcastle on the west. Northwest of the Black Hills proper, near the center of Crook County, lie the Bear Lodge Mountains, which are geologically a part of the same uplifted block of the earth's crust as the Black Hills, though topographically the two are distinct. The Black Hills, Bear Lodge Mountains, and associated uplands occupy about 4,000 square miles. Elevated areas are surrounded by the generally undistinctive topography of the Great Plains. The most striking of the



MAP I. BLACK HILLS STUDY AREA
WESTERN SOUTH DAKOTA AND NORTHEASTERN WYOMING

major topographical features in the outlying region is the famed South Dakota Badlands, which centers in the Badlands National Monument of southeastern Pennington County.

The lowest altitude in the area is about 1,900 feet, at the point where the Cheyenne River crosses the east border of Pennington County. The highest altitude is 7,241 feet at the summit of Harney Peak near the boundary between Pennington and Custer Counties. The plains range from about 3,500 feet along the east side of the Black Hills to about 2,400 feet in the eastern parts of Meade and Pennington Counties. West of the Black Hills, however, the plains for the most part are between 4,000 and 4,600 feet.

The Black Hills proper may be divided, in a broad way, into two parts. The west half is a broad plateau on a floor of limestone, roughly the same as the area shown on map 2 as having Paleozoic rocks; the east half is a hilly to mountainous region, shown mostly as Precambrian on map 2. The plateau is a scenic region of rolling uplands, for the most part above 5,500 feet in altitude and in places above 7,000 feet, but cut by such stream valleys as those of Sand, Cold Spring, and Spearfish Creeks in the northern Black Hills and a few lesser valleys in the southern Black Hills. The eastern half of the Black Hills has rugged topography in the granite area around Harney Peak, but otherwise consists of low mountains, many hills, broad valleys, and several localities with flat or gently rolling grasslands, locally called prairies or parks. Altitudes are mostly between 4,500 and 6,000 feet. Unlike the sparsely populated plateau region, the eastern part of the Black Hills has many towns, highways, tourist attractions, farms, and industrial establishments.

The northern part of the Black Hills contains many bodies of intrusive igneous rocks that are so resistant to erosion that they form hills and mountains after the softer rocks around them have been eroded. These conditions cause much of the rugged topography near Lead and Deadwood and in localities to the west near Tinton and in the Bear Lodge Mountains. Outlying localities have smaller but otherwise similar bodies of rock that cause such features as Devils Tower, Missouri Buttes, Inyan Kara Mountain, and Bear Butte.

Along the rim of the Black Hills are hogbacks and outward-sloping cuestas that mark the boundary with the Great Plains. A conspicuous feature of this border region is a remarkably continuous valley, with the form of a racetrack, cut into soft red shales and sandstones and thus sometimes called the Red Valley.

Beyond the foothill region lies a broad area associated with the Great Plains. The topography is characterized by broad, low ridges and smooth surfaces which are developed on a bedrock that is mostly soft shale. Within this region are the wide, shallow, terraced valleys of the Cheyenne and Belle Fourche Rivers and such major tributaries as Elk, Boxelder, Rapid, Spring, and Inyan Kara Creeks.

The Badlands of southeastern Pennington County is an area of steep slopes, numerous small valleys, and sparse vegetation. The rocks are largely soft claystone, easily removed by eroding processes, but there are also beds of firm sandstone that prevent the steep slopes from disintegrating. The spectacular effects produced by this rugged topography and by the various colors of the rocks make the Badlands an unmatched scenic feature. A more modest form of badlands topography occurs near Lusk, Wyoming.

General Geology

The Black Hills area ranks as a classic locality in the science of geology, as a consequence both of the great diversity of its geologic features and of man's success in putting its mineral deposits to beneficial use. Only a summary can be supplied here of the enormous number of publications that have been issued.

To acquire a simplified understanding of the geology of this area, one can imagine a scale model consisting of thin horizontal layers of clay and sand lying on a base of thick rubber. One can then suppose that a part of the rubber is pushed upward to form a dome-shaped structure, and at the same time glass rods are pushed through the bottom of the rubber near one end of the dome so that they enter the clay and sand layers. Finally, part of the clay and sand at the top of the dome is removed until the rubber and part of the glass rods show through the top of the model.

The clay and sand of this model are the shales, sandstones, and limestones that were deposited as sediments, mostly on the sea floor, at the various times in geologic history when the Black Hills area was inundated. The rubber represents the ancient crystalline rocks that form the basement beneath these shales, sandstones, and limestones, and come to the surface only in the central Black Hills. The glass rods are igneous rocks—that is, rocks originally molten—which rose from deep in the earth's crust to higher levels and there solidified. The domal structure is the Black Hills. And, finally, the material removed from the center of the dome to uncover the rubber was carried outward by streams and deposited as clays and sands to the east and west.

The basement rocks, if we may turn now from rubber to more sophisticated nomenclature, are mostly granite east of the Black Hills, so far as is known from deep drilling. Within the Black Hills, granite is abundant, mainly near Harney Peak. A course-grained kind of granite called pegmatite yields such economically valuable materials as mica, feldspar, beryl, and lithium in the Custer-Keystone region and near Tinton. Elsewhere, most of the basement rock consists of what were originally sandstones and shales but were long ago converted to mica schists and allied rocks when they were deeply buried and subjected to high temperatures and pressures. Among the several less abundant kinds of rock associated with these are iron formations of potential economic importance. The basement rocks are all of very ancient Precambrian age—some of the granitic rocks are 1,600 million years old and others are 2,400 million years old, as measured by techniques based on radioactivity phenomena.

The geologic record is blank between 1,600 and 600 million years ago. Thenceforth until nearly the end of the Cretaceous period, about 70 million years ago, the Black Hills area was periodically submerged by ocean waters in which were deposited great quantities of mud and sand. In time, these sedimentary materials solidified to form limestones, shales, and sandstones that make up the Paleozoic and Mesozoic rock units described briefly in table 1 and shown by the geologic map (map 2) to be widely distributed over the region. The thickness of these rocks reaches about 8,000 feet in northern Meade County and about 10,000 feet in western Niobrara County.

Near the end of the Cretaceous period the Black Hills dome was developed, at a time of widespread upwarping of the earth's crust in which the Rocky Mountains were formed. Some of the sediments deposited in the Black Hills region shortly before and shortly after this event have fossils of marine organisms and other evidence of a marine environment, but in the main the sediments of this and later times formed on the continent. With the birth of the Black Hills there came the rise of molten rock from deep in the crust to solidify as bodies of rhyolite and quartz monzonite porphyries and other igneous rocks in the northern Black Hills and the Bear Lodge Mountains. Most of the deposits of gold, silver, lead, and uranium probably also formed at about this time.

A mountainous topography much like that of the present day seems then to have been carved out by stream erosion. Subsequently, all of the area except the highest mountains was covered by stream-carried sediments and windblown volcanic ash, parts of which still remain among the Tertiary deposits shown on map 2. Later geologic history is mostly one of erosion by streams to remove this thick cover. The glaciers that had such notable effects to the north and east, beyond the Missouri River, did not extend to the Black Hills area.

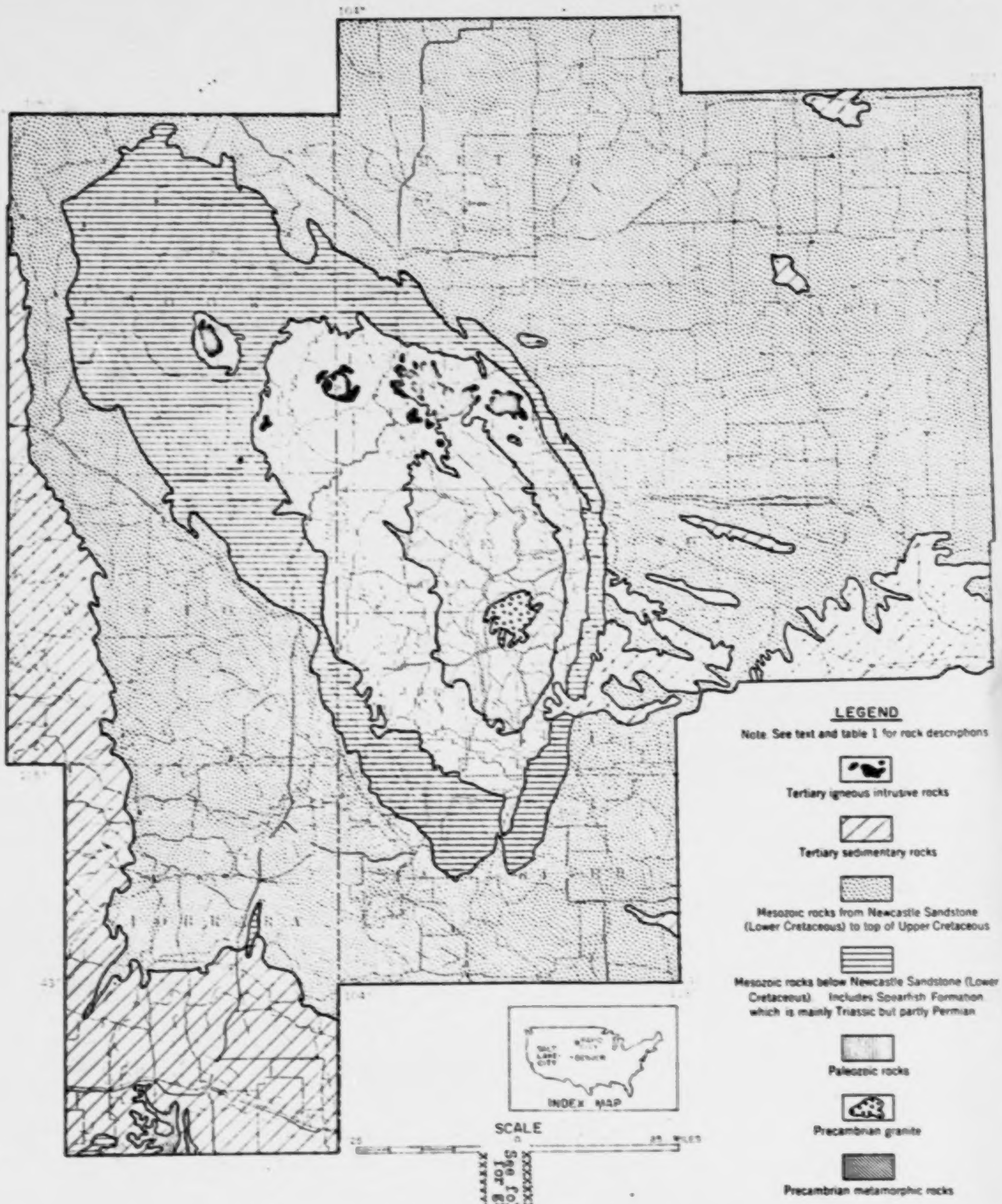
Climate

The climate of the Black Hills area is markedly different from that of the surrounding plains. Warm "chinook" winds and frequent sunny skies make the Black Hills the warmest part of South Dakota in winter. An additional moderating influence is the tendency for very cold air masses to seek low elevations. The arctic air outbreaks that blanket the plains, therefore, often bypass the higher elevations. Conversely, summer temperatures in the higher elevations of the Black Hills are cooler than those of the surrounding plains.

The freeze-free season is shortest in the higher elevations of the Black Hills, where brief freezing has been known to occur at any time of the summer.

Table 1.—Stratigraphy of exposed rocks in the Black Hills area

		Approximate average thickness, in feet	Names of principal formations, from youngest to oldest	Description
Cenozoic	Quaternary	--	--	Sand and gravel.
	Tertiary	3400	Ogallala Arikaree White River Fort Union	Mostly claystone, shale, and sandstone. Also conglomerate and coal.
Mesozoic	Upper Cretaceous	3400	Hell Creek(or Lance) Fox Hills Sandstone Pierre Shale Niobrara Carlile Shale Greenhorn Limestone Belle Fourche Shale	Dominantly shale. Also sandstone and limestone.
	Lower Cretaceous	600	Mowry Shale Newcastle Sandstone Skull Creek Shale Fall River Lakota	Mowry and Skull Creek are mainly shale. Other units are mainly sandstone.
	Jurassic	400	Morrison Unkpapa Sandstone Sundance Gypsum Springs	Shale and sandstone. Also gypsum, dolomite, and limestone in Gypsum Springs Formation.
	Triassic	600	Spearfish (in part Permian)	Red shale and sandstone. Also gypsum
Paleozoic	Permian and Pennsylvanian	800	Minnekahta Limestone Opeche Minnelusa (or Hartville)	Sandstone, shale, and limestone.
	Mississippian and Devonian	600	Pahasapa Limestone Englewood (or Guernsey)	Limestone and dolomite.
	Ordovician and Cambrian	500	Whitewood Deadwood	Sandstone, shale, limestone, and dolomite.
	Precambrian	--	--	Chiefly quartz-mica schist and mica schist. Also amphibolite and iron formation. Intruded by granite and pegmatite.


LEGEND
Note: See text and table 1 for rock descriptions
Tertiary igneous intrusive rocks
Tertiary sedimentary rocks
Mesozoic rocks from Newcastle Sandstone (Lower Cretaceous) to top of Upper Cretaceous
Mesozoic rocks below Newcastle Sandstone (Lower Cretaceous). Includes Spearfish Formation which is mainly Triassic but partly Permian
Paleozoic rocks
Precambrian granite
Precambrian metamorphic rocks
SALT LAKE CITY
DENVER
INDEX MAP
SCALE
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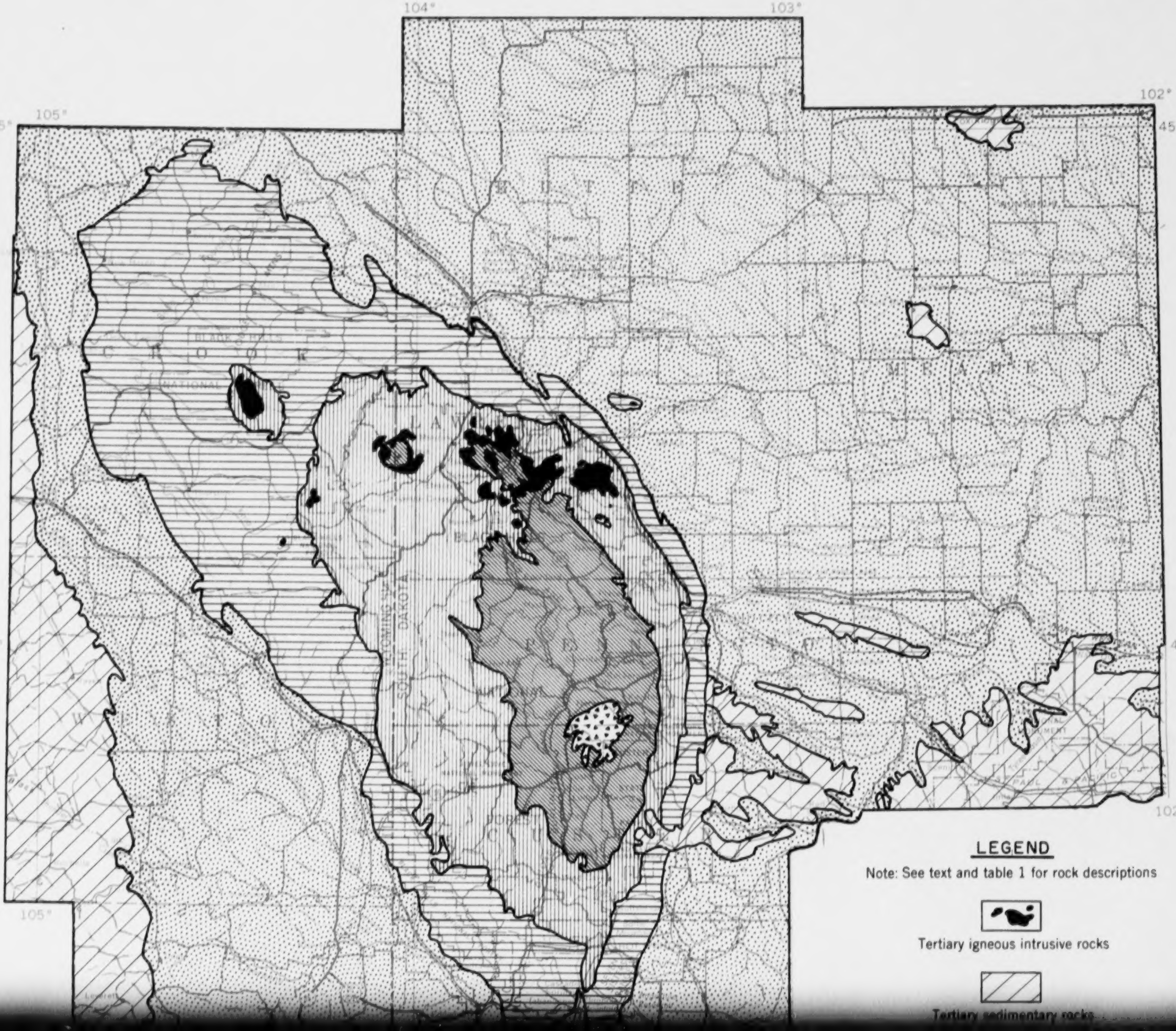
MAP 2. GENERALIZED GEOLOGIC OF THE BLACK HILLS AREA

See following page
for greater detail.

A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Tertiary igneous intrusive rocks
Tertiary sedimentary rocks

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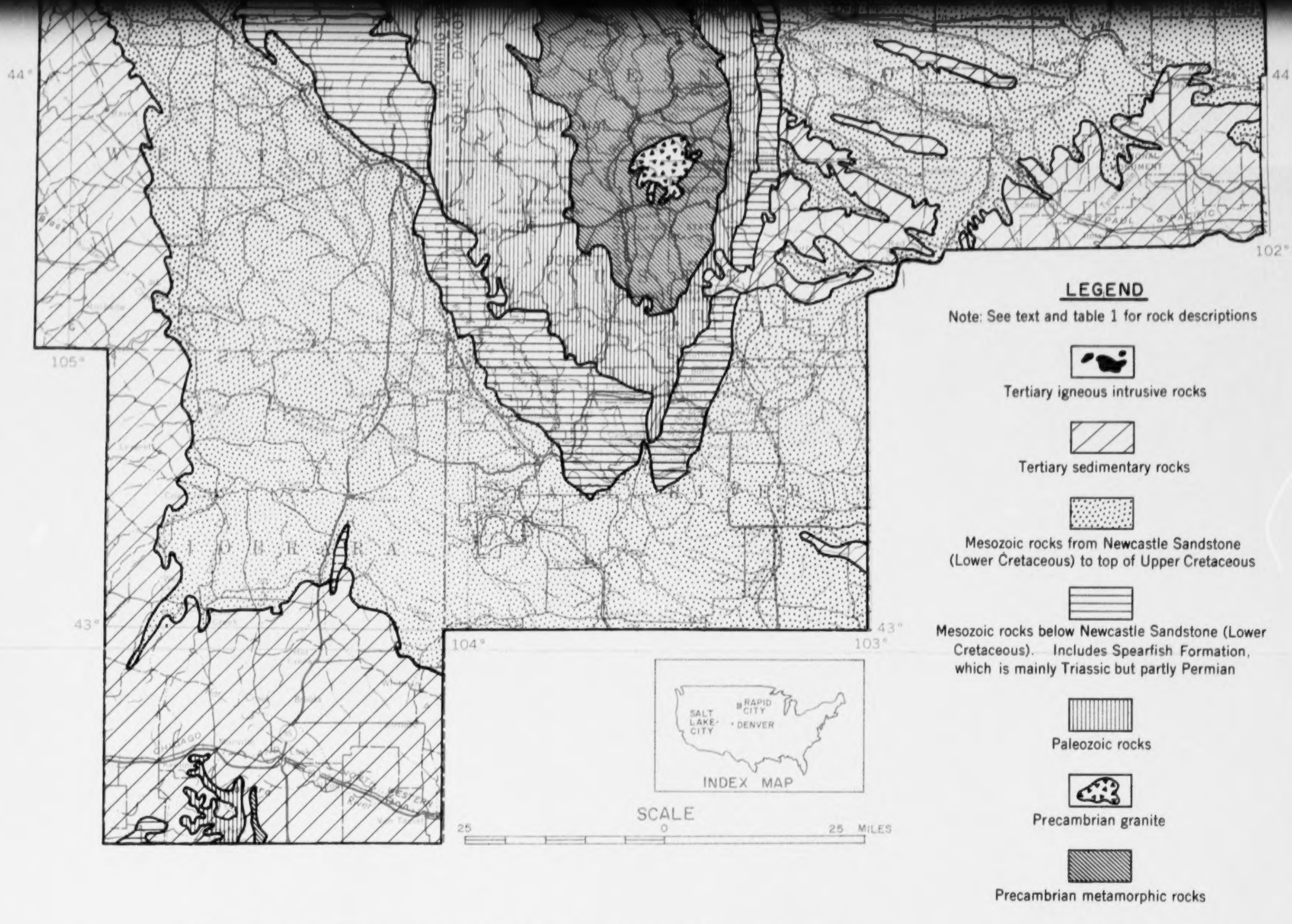
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SOUTH DAKOTA
WYOMING
LEGEND
Note: See text and table 1 for rock descriptions
Tertiary igneous intrusive rocks
Tertiary sedimentary rocks
Mesozoic rocks from Newcastle Sandstone (Lower Cretaceous) to top of Upper Cretaceous
Mesozoic rocks below Newcastle Sandstone (Lower Cretaceous). Includes Spearfish Formation, which is mainly Triassic but partly Permian
Paleozoic rocks
Precambrian granite
Precambrian metamorphic rocks
SALT LAKE CITY
RAPID CITY
DENVER
INDEX MAP
SCALE
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MAP 2. GENERALIZED GEOLOGIC MAP OF THE BLACK HILLS AREA

B

The average annual precipitation on the plains surrounding the Black Hills ranges from 12 to 15 inches. In the peripheral hogback part of the Black Hills uplift, the average annual precipitation ranges from 15 to 17 inches. In the central part of the Black Hills, the average annual precipitation ranges from 17 inches in the south, near Custer, to almost 28 inches in the north, near Lead.

Most precipitation falls during the growing season, April through September, with the maximum amounts usually occurring during May and June. The least precipitation is received during the winter. The higher elevations, especially in the northern part of the Black Hills, receive more precipitation as snow than do the lower elevations and the southern parts.

Variations in temperature and precipitation from year to year and locally in the same year are often large, as is typical for a continental type climate. The variations in the Black Hills area, however, are seldom as extreme as the variations in the surrounding plains area.

High winds are not infrequent, especially in spring and autumn, but the velocities of the winds are usually less in the Black Hills than on the plains.

During the summer months local thundershowers with spectacular lightning displays are common and they are occasionally accompanied by hailstorms of varying severity.

Table 2 summarizes some of the significant data available on the climate of the Black Hills area.

Soils

Most of the soils of the Black Hills area are shallow, rocky or eroded badlands soils as imposed by the local geology and physiography. Examples are: (1) the mountainous areas within the central Black Hills; (2) the limestones resistant to weathering found on the plateau; (3) the rough, hilly topography of the hogback ridges in the foothills; and (4) the badlands along valley walls of White River and tributary streams entrenched in the Great Plains.

Small scattered tracts of relatively shallow but usable medium textured limestone soils occur on smooth interstream divides of the plateau area. Other areas of deeper soils within the central Black Hills are restricted to the alluvials along stream bottoms.

The "Red Valley," locally called the "racetrack," contains many bodies of both old and young alluviums as well as some of deep permeable soils derived from the local limestones and shales. When deep enough over the underlying rock to have sufficient moisture retention, the Red Valley soils are valuable agricultural soils, both as dryland and, where irrigation water is available, as irrigable land.

Table 2.—Climatic features, Black Hills area

	Belle Fourche (miles)	Hot Springs	Lead	Sundance	Rapid City Airport	Vale
Station elevation (feet above mean sea level)	3,018	3,535	5,245	4,750	3,165	2,773
Average annual precipitation (inches)	13.09	16.06	23.81	16.77	14.71	15.45
Average annual total snowfall (inches)	30.7	36.4	100.1	93.55	39.2	--
Average annual temperature (^{o}F)	46.5	48.5	44.8	41.3	46.8	46.3
Highest recorded temperature (^{o}F)	112	112	101	105	109	113
Lowest recorded temperature (^{o}F)	-42	-41	-40	-39	-27	-39
Mean date of last spring freeze	May 13	May 12	--	May 31	--	May 16
Mean date of first fall freeze	Sept 23	Sept 27	--	Sept 18	--	Sept 24
Mean number of days between freezes	133	139	--	110	--	131

The smooth areas of plains soils are seldom as much as six feet deep over the Pierre shale, and so are intractable, drouthy, and largely used for range. Small areas of more useful soils are thicker and have greater moisture retention but are limited to alluvial terraces and bottoms along Rapid Creek and other streams fanning out from the base of the Hills.

Biologic Features

The Black Hills has been characterized as an evergreen island in a sea of grass. It is in truth a biologic nonconformity in the Great Plains, displaying features of both plains and mountains.

Lt. Col. R. Irving Dodge, who made a scientific exploration of the area in 1875, depicted it as a country "well watered and covered with grass even to the very top of the mountains." He goes on to describe pine forests liberally interspersed with parks, a variety of deciduous growth, and numerous small streams of cold, pure water. Colonel Dodge reported the animals of the Black Hills to include: numerous grizzly bears and black bears, a few cougar, a few lynx, numerous large timber wolves, numerous silver gray fox, some elk, a few mountain sheep, considerable numbers of black-tailed (mule) deer, and red (white-tailed) deer more abundant than any other animals. We can add to this historic list: bison, pronghorn, and game birds including turkey and grouse. No trout were originally present in Black Hills streams.

The natural conditions existing in the Black Hills were disrupted by the gold rush of the 1870's. Game populations, decimated by miners, settlers, and extreme winters, reached bottom in the 1920's. The grizzly bear, wolf, and turkey were exterminated. Audubon's sheep, a race of bighorn that flourished in South Dakota, became extinct in 1924. Other wildlife losses have been recouped to some extent by transplanting and other management measures.

Man's activities have left their marks in the Black Hills area. Road and building construction, farming, and mining have denuded relatively large areas of native vegetation. Much of the deciduous growth described by Colonel Dodge has been replaced by dense stands of pine and spruce. Although trout were planted in Black Hills streams as early as the late 1800's, conditions for their development have become far from ideal due to decreasing streamflows and increase in loads of sediment and other pollutants resulting from man's activities.

Much of the land is forested in the Black Hills proper. The remainder is a short- and mid-grass prairie.

PEOPLE

Very little is known about prehistoric man in the Black Hills area. However, salvage archeology at two or three early sites indicates that the early inhabitants of the area, probably about 5000 or 7000 B.C., were bison hunters who probably were organized socially into small hunting bands of several cooperating family groups.

On the fringe areas of the Black Hills there are indications of an impoverished people who lived precariously on small game around 4000 to 5000 B.C.

History

The history of the Black Hills area is essentially the history of the central heartland of the North American Continent and the drainage of the great Missouri River.

As the 17th century dawned, a Siouan-speaking family of Indian people occupied the northern half of the United States from the headwaters of the Mississippi River almost to the Rocky Mountains. This generic group was split into many smaller groups, but they were united by a common language or dialectic similarity. Next to the Algonquians, this was the largest linguistic group north of Mexico. It is now called the "Siouan" family, a name derived from a term applied to the largest and best known tribal group in the family, the Dakotas, which means "allied" or, according to some, "a large group of people allied by a common language." The Dakotas also were divided and subdivided. Characteristically, they were a bold and warlike people who lived in the forests around the small lakes at the headwaters of the Mississippi east of the Chippewas, but their influence was felt far beyond the borders of their traditional home.

It is generally agreed among present day historians that the Dakota people, first identified in a historical sense in the Jesuit Relation for 1640, were of the highest type physically, mentally, and probably morally. They conquered or drove out every tribe they opposed, except their neighbors the Chippewa; and their courage was never questioned, but the Chippewas called them "Nadowe-is-iw," meaning adder or snake and, by metaphor, enemy. The French Canadians of the time corrupted the Chippewa word to "Nadowessioux," then shortened the corruption to Sioux-Dakota.

According to legend, long before the Sioux headed toward the setting sun, the Mandans and the Hidatsa, both of the Siouan family, settled to the south of them, probably on or near the Missouri River. It was in this location that a large group broke away from the Hidatsa and called themselves Crow or bird people. They settled on the Missouri and its tributaries.

Back in Dakota country, the unrelenting war between tribes continued and when the Chippewas acquired guns from their French allies in the French and Indian war in the middle of the 18th century, the tide turned against the Sioux. Gradually the Sioux were forced to abandon the country they had so long inhabited at the headwaters of the Mississippi and to retreat to the south and onto the plains of the Missouri, driving the Kiowa and Cheyenne out of the Black Hills country, and pushing the Mandan and the Hidatsa up the Missouri River. Finally in 1837, decimated by their struggle, they ceded all their land east of the Mississippi to the United States.

Under the terms of the treaty of 1868, the Indians were guaranteed, as a permanent reservation, all land between the Missouri River on the east and the western boundary of Dakota on the west and from the northern boundary of Nebraska on the south to the 46th parallel or the Cannonball River on the north. The treaty also specified that the country north of the Platte River in Nebraska and east of the summit of the Big Horns in Wyoming was to be considered unceded Indian territory and no white man was to be permitted to settle or occupy any part or to pass through without the consent of the Indians.

The physical attributes of the Black Hills, primarily its gold and other minerals, were the magnets that drew the original white settlers, shaped and molded those who stayed and gave rise to the agriculture, mineral, and tourist economy that is so firmly entrenched today.

The Northern Plains was a part of the vast French colonial empire in North America until 1763, but was only sketchily explored and never colonized by the French who concentrated their activities east of the Mississippi.

The Verendryes, Louis-Joseph and Francis, were probably the first explorers to penetrate the area. It is said that in 1743 the two, in company with a band of Indians, entered the Hills area near the present city of Spearfish, South Dakota, then wandered south and east, and on March 30 of that year buried a lead plate on a bluff overlooking the Missouri River near the present site of Fort Pierre, South Dakota. The plate commemorated the discovery of the country and claimed it for the King of France.

The area, little changed since the Verendrye visit, was a part of the Louisiana Purchase of 1803, and was adjacent to the path of Captains Lewis and Clark in their epic struggle up the Missouri. The Lewis and Clark party spent more than two months in South Dakota, following the northwesterly course of the river. Its members did not see the Black Hills area, but French trappers told them of the fabulous "Black Mountains." In 1803, Prince Maximillian, at the mouth of the Bad River, called them the "Black Hills."

During the first half of the 19th century, virtually every creek and marsh in the vast Rocky Mountain region felt the moccasined foot of a trapper, and bale upon bale of prime beaver "plews" began a journey whose ultimate destination was a gentleman's hat rack in an eastern club. During this time the Black Hills area was trapped to some extent, but the Northern Great Plains was the last home of the Sioux and to them the Black Hills was a sacred place—a shrine to the lightning, the thunder, and the gods. The Indians went there to get lodgepoles and make medicine, but seldom stayed.

It was during this time that unconfirmed stories of gold in the Black Hills became commonplace and during the 1840's the Sioux, habitually at war with other tribes, began actively to resist the white influx that followed the discovery of gold in California and the stories of gold in the Black Hills. By 1851, Indian attacks demanded

Government intervention and a great peace council was called. In the resultant treaty the Indians pledged peace among themselves and with the Government, and agreed to allow citizens safe passage over Indian lands, but neither side actually lived up to the treaty terms.

It was not until 1855 that any reasonably accurate information was gathered about the Black Hills and surrounding territory. Lieutenant G. K. Warren and his party scouted the area in 1855 and again in 1857. It was on the expedition of 1857 that Lieutenant Warren named the highest peak in the Black Hills "Harney Peak" in honor of General William S. Harney, who at that time was in command of some military forces along the Missouri River in the Dakota-Nebraska area. General Harney was commander of the military district of the Black Hills in 1878.

The Fort Laramie Treaty of 1868, among other things,created the great Sioux reservation, including all South Dakota west of the Missouri River. It prohibited white penetration or settlement, but it did not actually stop penetration by whites nor attacks by Indians. Thus, it seemed in Washington that a military fort within the Hills was advisable. In 1874, Lt. Col. George Armstrong Custer led a party into the Hills to search for a site. Oddly enough, his party included a geologist and miners who occupied themselves with searching for gold. On July 30, 1874, near the present city of Custer, they found it in French Creek. The news spread like wildfire and was announced officially by military officials on August 12.

News of the gold discovery spread rapidly and in spite of the presence of hostile Indians and the issuance of military orders forbidding whites entrance to the Hills, a few parties of prospectors entered the forbidden land that fall and winter. More prospectors attempted to enter in the spring and summer of 1875, and the number increased in the fall and winter of 1875-76.

An insistent demand arose for opening of the Black Hills to prospectors, and the Government appointed a committee to negotiate with the Sioux with this object in view. When early negotiations failed, the military suspended its ban on prospectors entering the area, and negotiations with the Indians were continued.

An agreement was signed in October 1876 by chiefs of various Sioux tribes, but not by three-fourths of the male Indians. It was ratified by the Congress in February 1877. Under its terms, the Indians gave up their rights to the Black Hills, but the question of ownership is still in dispute.

As the mining activity increased so did the resentment of the Sioux. Spearfish and Crook City were frequent targets, and Rapid City, owing to its vulnerable location, was kept in constant terror. For more than eight years the Indians were seldom out of sight and never out of mind.

Many estimates have been made of the number of people engaged in the Black Hills gold rush. One of the more recent and careful researches is that of Watson Parker in his thesis, "The Black Hills Gold Rush, 1874-1879," which he submitted for his Ph.D. degree at the University of Oklahoma in 1965. The following statements on population are taken from Mr. Parker's thesis. By Christmas of 1875 there were 500 people in the general area of Custer and by mid-January of 1876 there were 4,000 people in the general Black Hills area, with the Custer area having a population of about 1,000 and the Hill City area about 500. The Custer area grew rapidly the first three months of 1876—someone, probably an optimist, estimated between 6,000 and 10,000 people. A somewhat more conservative estimate was that in 1876 there were some 7,000 men who came and went in the Black Hills area, with a peak population of about 5,000. In January 1876, there were 50 miners in the Deadwood Gulch area; by February 12, 1876, there were 400; and by March 6, 1876, there were 600.

Mr. Parker estimates population in May 1877 for the general area of various Black Hills towns to have been as follows:

Deadwood-Whitewood	5,500
Gayville (Central City)	3,000
Crook City	400
Centennial City	100
Rapid City	250
Bear Butte Gulch	500
Central Hills area	2,500
Floating population	3,000
Total	15,250

Many of the early immigrants came from the established east and west trails and headed north from Cheyenne, Wyoming. Thus, the Cheyenne-Deadwood Trail was one of the first established routes into the Hills. Another, known as the Sidney Trail, came from the south. From the east came the Fort Pierre Trail to Rapid City and thence to Deadwood. From the northeast came the trail taken by Custer, known as the Bismarck Trail, which linked Bismarck, Belle Fourche, Crook City, and Deadwood. Of lesser importance was the Montana Trail that came in from Bozeman.

At first, conventional, small-scale, placer-mining methods generally were used. Later, hydraulic mining was attempted. At Rockerville, a $250,000 investment was made in hydraulic equipment, but this and other hydraulic-mining efforts failed. After placer claims largely were exhausted, other means of extracting gold were tried. Stamp mills proved to be the most effective devices of that era.

The biggest gold producer in South Dakota was, and is, the Homestake mine at Lead. Discovered in 1876 by Moses Manuel, it produced bullion amounting to $301 million out of the total $358 million taken from the Black Hills area between 1876 and 1935. The discoverer Manuel sold the Homestake mine to capitalist George Hearst for $70,000 in 1877.

As the search for gold widened, the need for timber became acute. Wood was needed—some for homes, but mostly for dancehalls, sluice boxes, fuel, and mine timbers. The first sawmill in the area was built at Custer in February 1876. Seven years later more than 40 sawmills were operating in or near the Hills. In 1897, a Federal Forest Reserve was created and the Government supplied the bulk of Black Hills timber under a system of regulated tree harvesting. By 1960, the annual production of timber had grown to about 45 million board feet.

In the customary progression of settlement, farmers and ranchers followed the miners into the Black Hills country. Land was available and cheap. High prices were paid in the mining camps for coarse flour, for a fresh egg, or a side of bacon. Large cattle outfits were established along the foothills and on the range. The first water right for irrigation in the area was filed in May 1876 on Red Water Creek and, by 1899, 38,000 acres was under irrigation. The "Great Dakota Boom" increased the non-Indian population of South Dakota from 98,000 in 1880 to 330,000 in 1890.

Shortly after the mining boom began, freight companies were founded and many primitive roads were laid out. A railroad was completed from Chadron, Nebraska, to Buffalo Gap, South Dakota, in 1885 and on to Rapid City in 1886, and the Black Hills communities began to beckon tourists. Deadwood billed itself as the oldest and toughest town on the frontier and made legends of Bill Hickok and Calamity Jane. Chambers of Commerce were formed in various communities and publicity gimmicks and travel promotion campaigns devised to attract tourists, but the area was not immediately overrun. In 1906, Devils Tower (frontispiece) was designated a National Monument, the Nation's first.

In 1927, President Calvin Coolidge's visit to the area attracted much attention. For three months, Custer State Park was the hub of the Nation as the summer White House and on August 10, 1927, the President dedicated the work of mountain sculptor Gutzon Borglum. This enormous carving shortly became the greatest attraction in the State—Mount Rushmore National Memorial.

Population Characteristics

Distribution.--The Black Hills study area is in one of the least densely populated regions in the Nation—the Great Plains. The Black Hills proper, however, is one of the more densely populated areas in the Great Plains. In 1960, that area contained an average of 6.2 persons per square mile. In the same year the average population density for the State of South Dakota was 8.9 persons per square mile, while the comparable numbers for the nearby States of Wyoming and

Montana were 3.4 and 4.6, respectively. The United States average was 50.5 persons.

The extent of urbanization is one factor influencing population density of an area. In 1960, 57 percent of the population of the Black Hills study area was classified as urban—persons residing in cities with a population of 2,500 or more (table 3). In that same year, 39 percent of South Dakota's population was classified as urban while this population component made up one-half of Montana's population and 57 percent of the population in Wyoming. Nationally, 70 percent of the people were in the urban group.

The rural nonfarm population component—persons living in towns and cities with a population of less than 2,500 and other nonfarm persons living outside of incorporated places—was the next largest group in the study area. In 1960 nearly a third, 30 percent, of the population was classified into the rural nonfarm group. Most of the people in this group, approximately three-fifths, were nonfarm people who lived outside the boundaries of incorporated towns and villages. The remainder lived in 26 incorporated places having a population of fewer than 2,500.

In 1960 only 13 percent of the population of the area resided on farms or slightly less than the proportion classified as "rural farm" in the entire Missouri River Basin region. In this region, nearly 20 percent were rural farm people. In the area of North and South Dakota that lies west of the Missouri River, the rural farm segment was of considerably more importance, accounting for nearly 30 percent of the population.

Labor force.--The Black Hills study area had about 85,000 people in 1960 who could be considered potentially available for employment, including members of the Armed Forces. Of this potential, 53 percent were actually in the labor force, including 3.9 percent unemployed (table 4). 1/

The civilian labor force of 45,360 people is the most relevant of the various labor force measures of the basic economy of the Black Hills. This is so because the numbers of persons in the Armed Forces are determined by factors external to the study area. They are related, however, to the dynamics of the local economy and must be considered.

The presence of the relatively large numbers of Armed Forces personnel and the rate at which they increased from 1940 to 1960 are important elements in the economy of the area.

1/ The labor force, as used in this section, includes all persons 14 years old and over, employed or unemployed, and also members of the Armed Forces. The count was taken during the first half of April.

Table 3.—Black Hills study area—Population: percentage by component, 1940, 1950, 1960; percentage change, 1940 to 1950, 1950 to 1960

	Number of places	Number of people			Percentage by components			Percentage change	
		1940	1950	1960	1940	1950	1960	1940-50	1950-60
Total		91,152	102,506	127,870	100.0	100.0	100.0	12.4	24.7
Urban 1/.	8	39,152	53,211	73,351	43.0	51.9	57.4	35.9	37.8
Cities over 25,000 .	1	13,844	25,310	42,399				82.8	67.5
Cities 10,000 to 25,000	0	0	0	0					
Cities 5,000 to 10,000	1	7,520	6,422	6,211				-17.1	- 3.4
Cities 2,500 to 5,000	6	17,788	21,479	24,741				20.7	15.2
Rural nonfarm 2/. . . .	26	24,812	29,403	37,829	27.2	28.7	29.6	18.5	28.6
Towns 1,000 to 2,500	4	5,206	6,215	6,991				19.4	12.5
Towns 250 to 1,000. .	10	3,560	4,500	6,221				26.4	38.2
Towns less than 250 .	12	2,068	1,689	1,504				-18.3	-11.0
Other 3/.		13,978	16,999	23,113				21.6	36.0
Rural farm		27,188	19,892	16,690	29.8	19.4	13.0	-26.8	-16.1

1/ Cities with population in excess of 2,500 in 1960.
2/ Towns and villages of less than 2,500 persons and includes the fringe areas of urban places.
3/ Nonfarm population which lives outside the boundaries of incorporated places.

Table 4.—Black Hills study area—Employment status of population 14 years of age or over, 1960

Description	Number
Total available for employment a/	85,825
Civilian labor force	45,360
Employed	43,580
Unemployed	1,780
Not in civilian labor force b/	35,687
In Armed Forces	4,878

a/ Includes all persons of age 14 and over.
b/ Includes those in institutions, enrolled in school, retired, or those not classified as employed (housewife, etc.).

Personnel in the Armed Forces numbered 200 in 1940 in the study area. They increased to 2,782 in 1950 and by 1960 amounted to nearly 5,000. Thus, in 1960, they accounted for nearly 10 percent of the labor force of the area. In all of the western area of the Dakotas, Armed Forces personnel were only 5 percent of the total labor force in 1960, while in the entire Missouri River Basin 3 percent were in that group.

Although the impact of the Armed Forces personnel, in such relatively large numbers, on the local economy was not accurately measured in this study, their presence must be considered in looking at employment in the other nonagricultural sectors. The impact is generally most pronounced in the construction, trade, and service industries. For example, employment in the construction industry in the Black Hills increased nearly three times from 1940 to 1960. Yet, in the Missouri River Basin region, employment in this industry doubled during the same 20 years. Further, employment in retail trade, other than in food and dairy stores and eating and drinking places, nearly doubled in the Black Hills during this time period. In the Missouri Basin region, employment in this group increased approximately one and a half times from 1940 to 1960. The Armed Forces may not have been the only factor causing these differential changes, but without doubt they exerted a definite influence.

Of the 43,580 civilian employees in 1960, slightly more than three-fifths were persons working for private firms for a salary. Self-employed persons comprise a fifth of the labor force. Government workers—Federal, State, and local—made up 18 percent of the total, and unpaid family workers 1.5 percent of the civilian labor force.

Self-employed workers made up a larger share of total agricultural employment than in the nonagricultural industries. Conversely, wage and salary workers were more important in the nonagricultural industries than in agriculture.

A summarization by major industry groupings is shown in table 5. More than three-fifths (65 percent) of the total employment was found in the noncommodity-producing industries, i.e., services, trade, and education. Other commodity-producing industries provided employment for about 15 percent of the employees. The contract construction industry accounted for more than half of this employment, 8.7 percent of the total employment. Agriculture, including forestry and fisheries, employed 13 percent of the labor force while manufacturing required 7 percent. 2/

Table 5.—Black Hills study area—Employment by major industry components, number and percentage distribution, 1940, 1950, and 1960. a/

	1940	1950	1960	Percent of total		
				1940	1950	1960
Agriculture b/	8,785	8,470	6,260	30	21	13
Manufacturing	2,229	2,487	3,580	8	6	7
Other commodity-producing industries c/	4,723	5,991	7,167	16	15	15
Noncommodity-producing industries d/	13,529	23,097	31,451	46	58	65
Total	29,266	40,845	48,458	100	100	100

a/ Employees not reporting industry of employment were distributed among the industries on the basis of distribution of those who did report.

b/ Includes agriculture, forestry, and fisheries.

c/ Other than agriculture and manufacturing.

d/ Includes Armed Forces.

Trends.--During 1950 to 1960, the population growth rate of the Black Hills area was higher than that of the Nation, South Dakota, or Wyoming. Only 14 States had a higher growth rate than the Black Hills during this decade.

The major portion of the increase was in the urban sector. The urban population was 43 percent of the total in 1940 and had increased to 57 percent by 1960. At the same time, the rural farm population decreased in number and as a percent of total population. Rural farm

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2/ The lumber and wood products categories are included in manufacturing.

population was nearly 30 percent of the total in 1940 and only 13 percent in 1960.

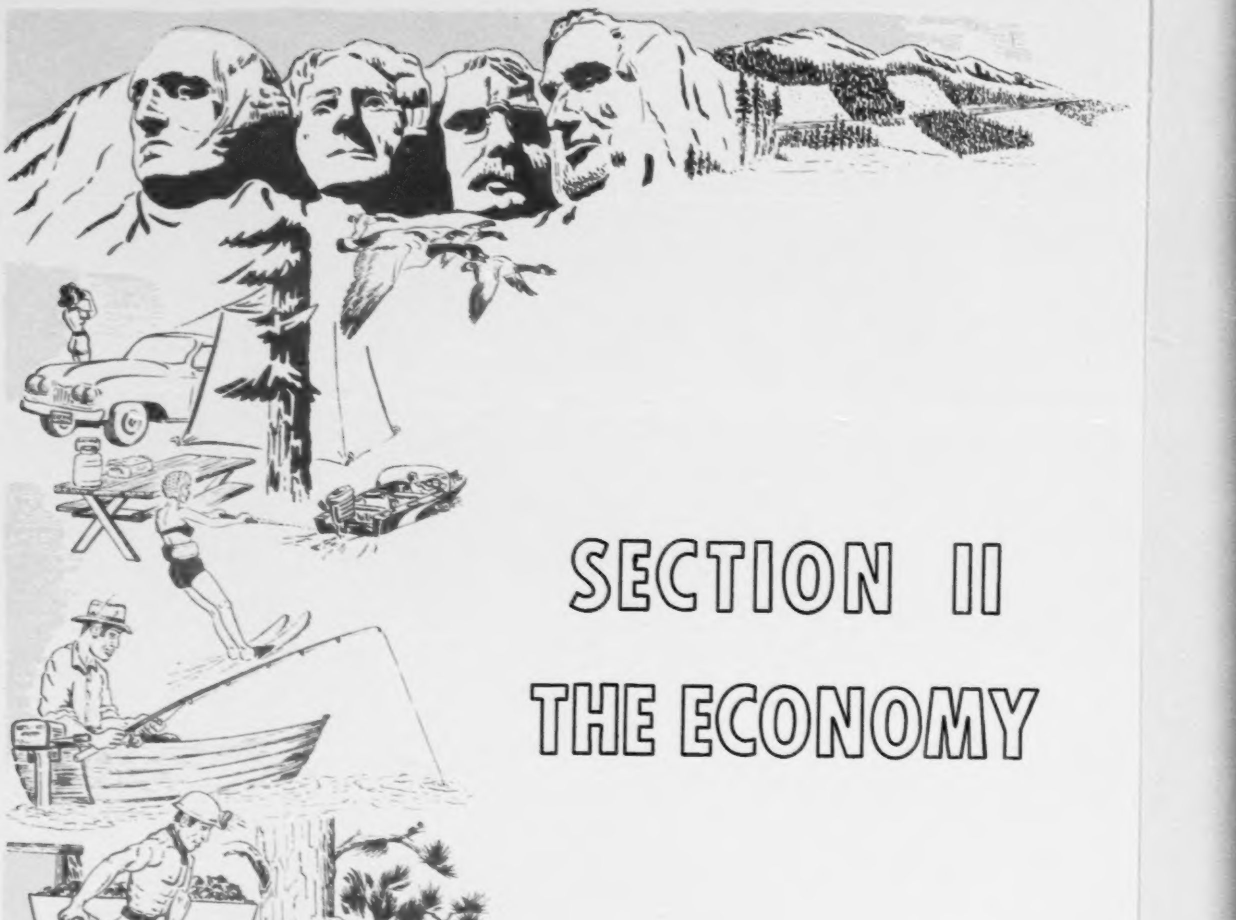
The urban sector increased in population from 39,152 in 1940 to 73,351 in 1960, a 36 percent increase in the first 10 years and a further increase of 38 percent in the last 10 years. In this latter period, approximately 80 percent of the net gain in total population was in the urban sector.

The rural nonfarm population gained 19 and 29 percent during the 1940-50 and 1950-60 periods, respectively. The farm population decreased 27 and 16 percent during these same periods.

Similar trends are evident in employment. Employment in agriculture as a percent of total employment declined from 30 percent in 1940 to about 13 percent in 1960. Manufacturing and other commodity-producing industries increased from 46 percent to 65 percent.

SECTION II

THE ECONOMY



THE ECONOMY

The economic environment of the Black Hills area differs considerably from the surrounding areas in South Dakota and Wyoming. Varied fields of activity have significant economic impacts on this area, more so than is generally true for the two States as a whole.

Tourist and outdoor recreation, including hunting and fishing, forestry operations, and mining industries are concentrated in this area and, therefore, contribute a greater proportional share to the Black Hills economy than in any comparable area of South Dakota or northeastern Wyoming. Governmental and military installations are also important segments of the economic structure in the area.

The area includes 13,107,840 acres of land; the 1960 population was 127,870; and the population density was 6.2 per square mile.

AGRICULTURE

Description

Development of agriculture in the Black Hills began shortly after gold was discovered. About 1900, homesteaders began to move into the area and, during the following decade, the open range came to an end. The drought of 1910-11 forced another adjustment in the area's agriculture. Many homesteaders left the area while those who remained began to raise some livestock, and ranchers accepted a modified system of ranching by raising forage and feed crops for winter feed. Years of ample rainfall, followed by severe drought, have been commonplace in this area.

About 57,000 acres is under irrigation on the Belle Fourche Irrigation Project and about 12,000 acres on the Angostura Unit. Both projects were developed by the Bureau of Reclamation. Approximately 34,000 acres is irrigated from privately developed irrigation systems in the Hills area. Thus, a total of 103,000 acres was under irrigation in 1959.

Of the 13,107,840 acres in the area, nearly 83 percent or 10.8 million acres was in farms in 1959.

Beef cattle enterprises provided about 64 percent and sheep enterprises about 18 percent of the gross value of farm marketings in 1959. In most cases, cattle and sheep were marketed as feeder stock. Table 6 shows cash farm sales by source of income.

Crop sales amounted to about 12 percent of the total cash farm marketings in 1959. Most of the feed crops were fed to livestock on the farm. Winter and spring wheat were the major dryland cash crops.

Table 7 shows the distribution of farms by type of major farm enterprise in 1959. Livestock farms predominate, and because 73 percent of the farms received over half of their gross income from sales of livestock.

Effect on the Economy

Changes in the agricultural industry include declining farm population, farm employment, numbers of farm units, and commodity prices. Other elements changing in the opposite direction include increasing total production, production per farm, production per man, acreage per farm, sales per farm, capital investment, and prices.

Farm population declined from 27,188 in 1940 to 16,690 in 1960, a decrease of 39 percent (table 3). This decline illustrates the massive adjustments being made in the agricultural industry because of technological advances and alternative economic opportunities. The decline in farm population can be expected to continue, although the rate of decline is expected to decrease in the future.

Farm employment has decreased along with the decrease in farm population. Agricultural employment decreased from 8,584 in 1940 to 5,896 in 1960, a 31.3 percent decline.

Number of farm units of all types totaled 4,242 in 1959. This represents a decrease of 19 percent from 1949 when there were 5,253.

The average size of farms in 1940 was 2,007 acres. By 1959, this had increased some 27 percent to 2,550 acres per farm. In 1959, nearly 35 percent were in excess of 2,000 acres (table 8). More than a half (56 percent) were in excess of 1,000 acres.

Cash sales of agricultural commodities increased from $31.3 million in 1954 to $50.2 million in 1959, a gain of 47 percent. During the same period realized gross farm income increased from $46.1 million to $63.6 million. Total farm production expenses exceeded $29.4 million in 1954 and $39.8 million in 1959. Thus, total realized net farm income increased from $16.7 million in 1954 to $23.8 million in 1959. The decline in farm numbers and the increase in realized net income raised net income per farm from $3,500 to $5,600.

Table 6.—Cash farm sales, by enterprises, 1959, Black Hills area

Enterprise	Cash sales	
	Amount	Percent
All crops sold:		
Field crops	$ 5,837,000	11.6
Fruits and vegetables	34,000	.1
Forest products	253,000	.5
Total	$ 6,124,000	12.2
Livestock sold alive:		
Cattle	$31,961,000	63.8
Sheep and lambs	6,822,000	13.6
Hogs and pigs	561,000	1.1
Horses	113,000	.2
Total	$39,457,000	78.7
Livestock products:		
Dairy	$ 2,074,000	4.1
Wool and miscellaneous	2,100,000	4.2
Poultry	387,000	.8
Total	$ 4,561,000	9.1
Grand total	$50,142,000	100.0

Source: 1959 U. S. Census of Agriculture.

Table 7.—Farms by type of farm, 1959, Black Hills area

Type of farm	Percent of total
Cash grain	4.1
Other field crops	.9
Poultry	.1
Dairy	3.0
Livestock, other than poultry and dairy	72.5
General	2.7
Miscellaneous	16.7
Total	100.0

Source: U. S. Bureau of the Census, U. S. Census of Agriculture, 1959.

Table 8.—Farm characteristics—Number of farms by size class and percentage distribution, 1949, 1954, and 1959, Black Hills area

Size class	1949 No.	1949 Percent of total	1954 No.	1954 Percent of total	1959 No.	1959 Percent of total
99 acres or less	519	10	390	8	282	6
99 to 259 acres	593	11	523	11	412	10
260 to 499 acres	704	13	601	12	496	12
500 to 999 acres	960	18	850	18	674	16
1,000 acres or more	2,491	48	2,428	51	(2,378)	(56)
1,000 to 1,990 acres	(1/)	--	(1/)	--	911	21
2,000 acres or more	(1/)	--	(1/)	--	1,467	35
Total	5,253	100	4,802	100	4,242	100

1/ Farms for these size classes were not counted as separate groups in the 1949 and 1954 censuses.

In 1959, 84 percent of the farms were classified as commercial farms. Fifty-five percent of these commercial farms had sales amounting to between $5,000 and $20,000 and 19 percent had sales in excess of $20,000.

Agriculture as Related to Black Hills Economy

Agriculture is an important segment of the Black Hills economy. However, the gold, uranium, forest products, and recreation industries and military installations point up fundamental economic differences between this area and the surrounding portions of South Dakota and Wyoming. The Black Hills area is less dependent on agriculture as a source of basic employment and income than many other portions of the Great Plains.

South Dakota is more dependent on agriculture as a primary source of income than any other State. However, in 1965, in the six-county portion of the study area in South Dakota, agriculture contributed only 7.4 percent to total personal income of the area as compared to the State average of 21 percent.

TIMBER

Timber cutting began in the early days of the Black Hills gold rush and there is evidence that at least two portable steampowered sawmills existed by 1877. Within a decade intensive timber cutting caused a rapid depreciation of quality in native stands adjacent to mining operations.

President Cleveland withdrew most of the forested land in the Black Hills from entry and created the "Black Hills National Forest Reserve" on February 22, 1897. No provisions were made for either administering or protecting the timber resource. The Timber Reserve Bill was enacted later that same year and authorized the Secretary of the Interior to sell Federal timber.

Administration of the Black Hills National Forest Reserve was provided by a supervisor and his rangers headquartered at Custer, South Dakota.

Around the turn of the century much of the remainder of the public domain in the Black Hills area was dispersed into additional claim lands, homesteads, "school lands," and State and national parks and forests. All lands remaining in the public domain were placed under the administration of the Bureau of Land Management in 1946.

Lands administered by the Bureau of Land Management that support commercial stands of timber are found in six of the nine counties in the Black Hills area: Meade, Custer, Fall River, and Lawrence Counties in South Dakota, and Crook and Weston Counties in Wyoming.

The timber industry developed rapidly during early years of settlement in the Black Hills. Vast quantities of wood products were supplied to the mines, railroads, and other industries and businesses coming to the area.

Major Timber Enterprises

Sawmills.--Sawmills operating in the Black Hills traditionally have been of small size. There are now only three sawmills that may be classed as large.

The number of active sawmills located in the area, and their estimated capacities, are as follows:

	Number	Annual capacity (million board feet)
	3	Over 10
	3	5 to 10
	16	1 to 5
	6	Less than 1
Total	28	

Twenty-nine sawmills have suspended operations in the Black Hills since 1960. Most of the sawmills that closed were quite small. This shutdown capacity caused a decline in lumber production through 1962. In 1963 lumber production again swung upward and by the end of 1965 production had returned to the 1960 level.

Pulp and paper manufacture.--Shipments of ponderosa pine pulpwood logs (roundwood) began in 1947. Volume shipped did not become significant until late in 1958 when a railroad established a special rate for multiple carloads. Since 1958 the volume of pulpwood exported to Wisconsin has increased steadily. An estimated 45,000 cords was shipped in 1964.

Logging and milling residues in the past have been of little value locally because of the lack of markets. Currently, about 50 percent of the total residue is being utilized. The residue is used for pulp chips, lath, engineering stakes, fuel, etc.

There are two plants in the Black Hills that chip for pulp. One chips its own waste, and the second plant chips wastes from other mills. All of the chips are shipped to paper mills in Wisconsin (graph 1).

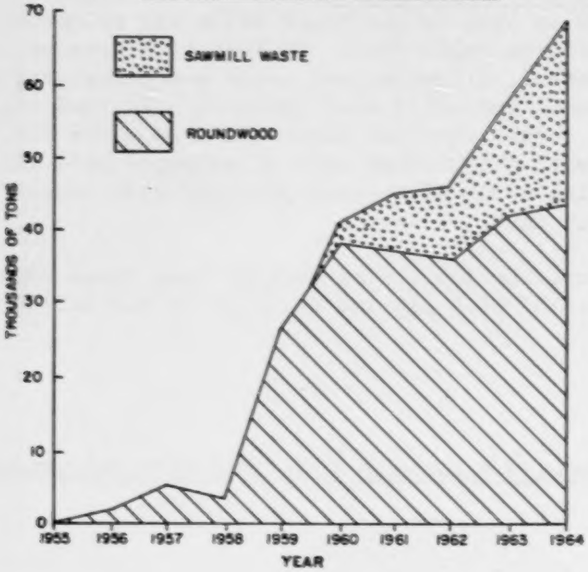
Post and pole industry.--The post and pole industry has been established for many years in the Black Hills and has maintained a steady growth. The most significant increase has come about through more efficient pressure treating methods. There are ten active treating plants in operation which produce about 60,000 cords of treated post and pole products per year.

Several areas of Rocky Mountain juniper in the Hills area are important sources of fence and pole material for local ranchers.

Contribution to the Economy

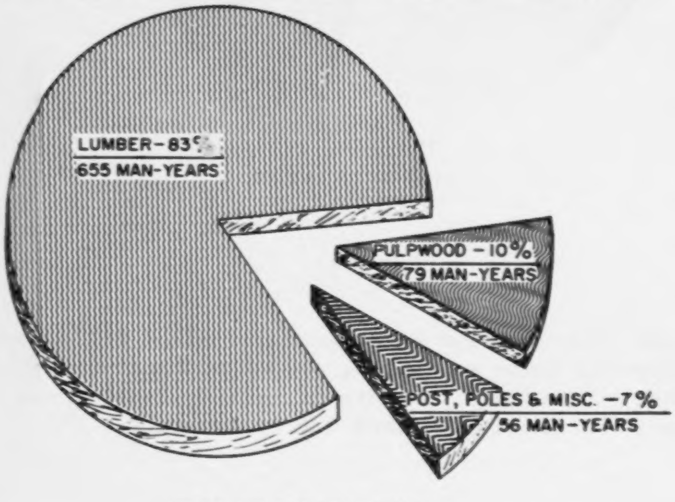
Employment.--In 1964 the Black Hills timber industry, through the primary processing phases, provided approximately 790 man-years of employment. The estimated total payroll for these wood-industry employees was about $3,850,000 per year. The "Timber Industry Employment"

GRAPH I. PRODUCTION OF PULP FIBERS



graph that follows shows the estimated employment in each of the major timber industry components.

GRAPH 2. BLACK HILLS TIMBER INDUSTRY EMPLOYMENT IN 1964

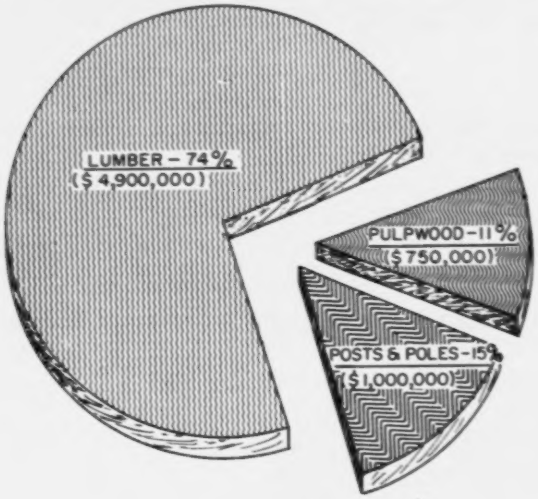


TOTAL OF 790 MAN-YEARS

Volume and value of production.--The total volume of primary wood products produced in 1964 in the Black Hills was estimated to be in excess of 21.8 million cubic feet. Of this total production, about 71 percent was lumber, 5 percent was posts and poles, and about 24 percent was pulpwood and other wood products. In 1964 the average selling value of lumber from the Black Hills area was $72.53 per thousand board feet; the average cord of pulpwood sold for $16.50; and the average selling price of treated post and pole material was $864 per thousand cubic feet.

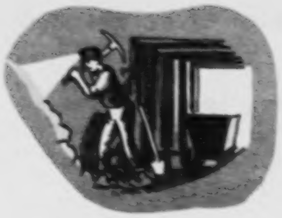
The total contribution to the economy from these major wood products was in excess of $6.5 million as shown in the following illustration:

GRAPH 3. VALUE OF BLACK HILLS WOOD PRODUCTS TO THE ECONOMY (1964)



TOTAL OF $6,650,000

The trend of production of these major Black Hills wood products (lumber, pulpwood, posts and poles, and other wood products) has been generally that of a steady increase in recent years except for treated posts and poles which has remained fairly constant.



MINERALS

Description

Mining in the Black Hills had its inception with the gold rush of 1874-79. Mica mining started soon afterward. In the early 1880's, silver mining flourished in the Hills until litigation (1883) and a drop in the price of silver (1891) caused its collapse. A tin boom developed in the Keystone-Hill City and Tinton areas in 1884-94, but the bubble burst when it was discovered that the ores were neither so rich nor so abundant as at first thought. Coal mining began in the Cambria area north of Newcastle in 1889, and it may be said that the local petroleum industry had its start in 1887 when crude oil was collected from seeps and shallow wells in the Moorcroft area, and first was shipped to the mines of the northern Black Hills.

World War I stimulated the development of extensive tungsten deposits in the northern Hills and gave added impetus to the mining of sheet mica for the rapidly growing electrical industry. Bulky nonmetallics came into their own in the decade after the war, with rapid development of the feldspar and bentonite industries. Discovery of commercial oil accumulations at Mule Creek in Niobrara County and Osage in Weston County, Wyoming, in 1919, marked the first real impact of that industry upon the local economy.

World War II developed a strong demand for domestic mica, beryl, and lithium minerals. Artifically high prices and some subsidies stimulated local mining of beryl, sheet mica, lead and zinc, and the lithium minerals, but production dropped off following a return to normal prices.

A major discovery of oil along Mush Creek in Weston County, Wyoming, in 1944, started a period of exploration and development south and west from Newcastle and Osage that lasted for several years, and was followed by active exploration west and north of Moorcroft.

The most recent mining boom followed the discovery of uranium ores in the Cretaceous sandstones in 1951, and the completion of a processing plant at Edgemont in 1955. The current Government purchasing contract expires in fiscal year 1967, and mill operation after that will depend on the ability of the company to make sales of uranium concentrates to private industry.

Construction of major dams on the Missouri River, the interstate highway system, and the numerous defense installations in North and South Dakota and eastern Montana and Wyoming has greatly stimulated the production of sand and gravel, rock, and cement from the Black Hills area.

Major enterprises and industries.--The outstanding single enterprise is the gold operation of the Homestake Mining Company at Lead. It provides steady year-round employment to 1,777 persons directly, and in 1964, shipped bullion worth a record $21,592,000 to the U. S. Mint.

The uranium mill at Edgemont processed an average of 542 tons of uranium ore per day in 1964. It employed 62 persons, and produced a uranium oxide concentrate valued in excess of $5 million. The mill treated ores from 29 mining operations in the area, each employing from 2 to 40 persons. The largest mine operated steadily throughout the year; many smaller mines were part-time or seasonal in operation.

In 1964 approximately 27,000 tons of feldspar was produced in the area. The largest producer was the International Minerals and Chemical Corporation which gave steady employment to 25 persons in 1964.

Seven bentonite mills, scattered around the north and west sides of the Hills from Osage, Wyoming, to Belle Fourche, South Dakota, employed a total of 249 individuals. Mining and hauling operations are seasonal; milling is a reasonably steady year-round operation.

The State Cement Plant at Rapid City shipped 2,044,000 barrels of cement valued at $7,073,000 in 1964. It employed 185 persons on a year-round basis. A midwinter shutdown is utilized for maintenance, repair, and vacations.

Petroleum operations, conducted in 57 fields in the nine-county area in 1964, produced about 11 million barrels of crude oil. Two refineries in the area have a combined capacity of 7,565 barrels of oil per day, and employed 89 persons in 1964. Field installations treated a total of 5,800,000 cubic feet of natural gas per day, recovering 16,900 gallons of combined natural gasoline and LP gases. No effort has been made in this survey to determine the number of pumpers, service crews, and drilling crews used to maintain production.

Several operators produced crushed rock valued at $2,416,000 in 1964.

Effect on and Contribution to Economy

Employment and trends.--The mining and processing of metallics and nonmetallics in the nine-county area utilizes the services of about 2,450 persons, and the petroleum industry probably adds about 100 to this total. Most are full-time jobs. Some seasonal jobs exist because demands for the commodities are related to construction or other seasonal industries. Many open pits close during winter months, reducing the employment of miners, handlers, and truckers.

Employment has not increased with production primarily because of technological improvements on the part of larger operators. Homestake, for instance, now employs 250 fewer men than it did just prior to World War II, but has been able to increase the tonnage mined and milled by 1,450 tons per day.

The number of small pegmatite mining operations is probably at a 40-year low, and the figure will remain small unless abnormal demands develop for feldspar, mica, beryl, and lithium minerals, or for one of the lesser minerals produced as byproducts.

Should mining and milling of uranium ore cease at the expiration of the Edgemont Mill's contract with the AEC, it would terminate more than 100 full-time and many part-time or intermittent jobs.

Income and trends.--Despite fluctuations in the demand and production of individual commodities, the overall mineral industry has demonstrated a picture of steady expansion and progress. By 1964, mineral production for the nine counties was approaching $75 million, compared with $67 million in 1960. Table 9 shows value of production by counties, and a listing, in decreasing order of importance, of the commodities contributing to the totals.

In this area, where active exploration and development are in progress, value of commodities does not tell the entire story of the benefits that accrue to landowners and other residents of the area. Annual rentals are paid to landowners for undeveloped or unexplored oil and gas leases and for leases held for future development of sand and gravel, bentonite, and uranium. Expenditures for annual assessment work on mining claims are usually made locally for labor and supplies.

Production royalties, actually part of the value of the commodities involved, are paid on uranium, oil and gas, sand and gravel, rock, and bentonite, on either a tonnage or ad valorem basis. Information on income to private landowners from these sources is not available.

As an example of the importance of rentals and royalties to State and county governments, the following figures for 1964 for the three counties of Crook, Niobrara, and Weston in Wyoming have been supplied by A. E. King, Commissioner of Public Lands for Wyoming:

Table 9.—Value of mineral production, Black Hills counties

County	1960	1961	1962	1963	1964	5/ 1965	Commodities in descending order of importance, 1964
Butte, S. Dak.	$1,297,862	$648,557	$725,209	(1/)	(1/)	(1/)	Clays, sand and gravel, lime.
Crook, Wyo.	2/ 18,438,053	20,444,995	22,869,929	$24,074,535	$25,892,100	$27,726,287	Petroleum, clays, uranium ore, stone, natural gas, vanadium, sand and gravel.
Custer, S. Dak.	2/ 685,214	734,266	702,307	1,039,798	614,380	464,628	Feldspar, stone, petroleum.
Fall River, S. Dak.	2/ 642,825	365,924	282,286	312,816	474,893	250,187	Uranium ore, vanadium, sand and gravel, stone.
Lawrence, S. Dak.	19,609,878	19,747,169	20,574,158	20,767,795	22,122,992	22,381,179	Gold, sand and gravel, silver.
Meade, S. Dak.	156,151	165,665	455,455	504,649	310,000	186,000	Sand and gravel.
Niobrara, Wyo.	3/ 3,103,698	3,179,560	2,997,010	2,595,000	2,607,000	2,838,916	Petroleum, natural gas, sand and gravel, LP gases.
Pennington, S. Dak.	10,555,075	11,014,262	11,016,445	9,351,442	9,622,948	7,557,035	Cement, stone, sand and gravel, lime, clays, gypsum, scrap mica, feldspar, lithium, gold.
Weston, Wyo.	12,620,734	16,744,045	11,332,106	10,766,443	11,952,831	12,061,195	Petroleum, clays, LP gases, natural gas, natural gasoline, sand and gravel.
Area totals	$67,109,490	$73,044,443	$70,954,905	4/ $69,412,478	4/ $73,597,144	4/ $73,465,427	

1/ Withheld to avoid disclosing company confidential data.
2/ Excluding vanadium.
3/ Excluding natural gas and natural gas liquids.
4/ Partial total excludes Butte County, South Dakota.
5/ 1965 data are presented to give reader latest information available. Text has not been modified to reflect 1965 data.

Petroleum produced on State lands (in bbl.)	958,000
State royalty (12.5 percent on above)	$ 279,000
Mineral rentals for leases on State lands (est.)	115,000
Bentonite royalties on State lands (est.)	30,000
Rentals and royalties on Federal lands collected by Federal Government for counties	768,000
Total royalties and rentals accruing to State and county governments from public lands in three Wyoming counties	$1,192,000

Data similar to above for counties in South Dakota portion of the Hills area are not available except that the Bureau of Land Management remitted about $75,000 to the six counties in South Dakota as their share of mineral leases and permits on Federal lands managed by the Bureau of Land Management in fiscal year 1965.

RECREATION

Description

For the entire nine-county area, the recreation-tourism industry shares the number one spot with the minerals industry in revenue production and general importance to the region. In the South Dakota portion of the area, the booming recreation industry is clearly the revenue-leader. Tourism is of relatively less significance in the lightly developed and populated three-county area in Wyoming, but it is still an important industry. In 1954 tourism was the number five contributor to the economy of northeastern Wyoming and is now conservatively estimated to be the third or fourth most important industry there. The importance of Black Hills tourism has been increasing each year. The ever-important private sector of the tourist industry is just beginning to realize the impact the tourist dollar has upon the area economy. The South Dakota Department of Highways has estimated that during 1963 some $10 million in private capital was invested in tourist facilities, and an equal amount was programmed for 1964. A lesser, though substantial, amount of money was invested in recreation improvements in recent years by the public sector.

Forecasts made by the State Highway Department indicate that within 5 years, South Dakota can expect an annual influx of five to six million tourists and as much as $700 million in tourism-based income.

It is entirely possible that before long outdoor recreation will surpass all other industries in revenue production and be the number one industry in both the Black Hills and the entire State of South Dakota. In Wyoming, the industry likely will reach the number two position. A recent economic study pointed out that the promotion and development of tourism carries the "most significant immediate potential" for diversifying South Dakota's economic base and making a major improvement in the State's income.

The Black Hills area is a nationally known recreation area. Crowded within its boundaries are outstanding forests, 7,000-foot mountain peaks, amazingly rugged and twisted rock formations, tumbling streams, deep blue and green lakes, unique caves, a wide variety of wildlife, and a refreshing summer climate. Manmade attractions provide a wide variety of other things to see and do. In addition to its attractions, the region is a plains-surrounded island so situated as to attract and capture many visitors that are enroute to vacation targets in other areas. These attributes, all well-publicized, create an outstanding income-producing resource for the area.

Effect on and Contribution to the Economy

Income.--During 1964 nearly three million tourists spent more than $75 million in the Black Hills and Badlands region. The actual boost to the economy or "total personal income" produced by this impact has been estimated to be between $170 and $200 million. Overall travel and dollar volume were up about 1.5 percent over 1963, a small but very respectable increase considering the drawing power of the first year of the New York World's Fair and the general downward trend of tourist travel in this region in 1964. The 1962 and 1963 period saw an average annual increase in dollars spent of 8 percent while visitation rose 12 percent each year.

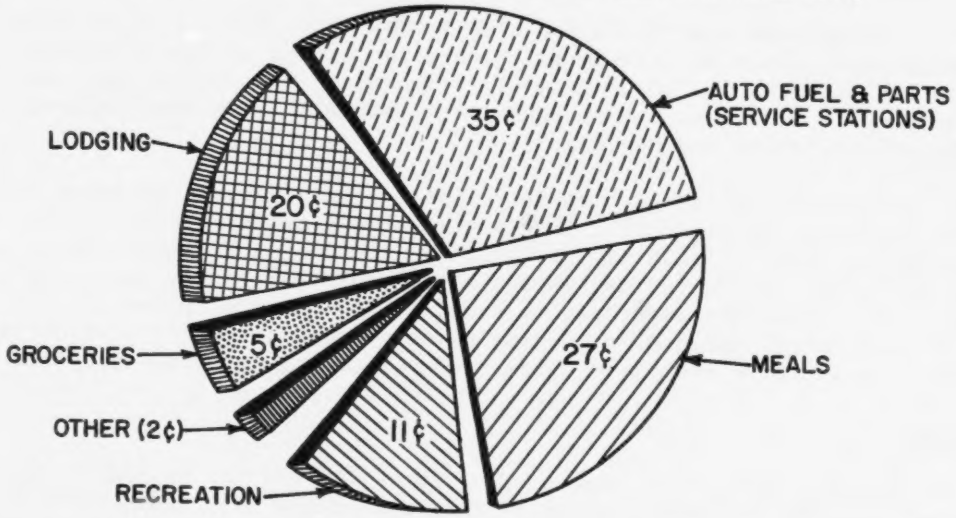
Visitation figures for 1965 indicate that it was a record year. Tourist dollar volume rose by about 20 percent while attendance climbed approximately 15 percent over 1964. Paid camping showed a whopping increase of 45 percent. For the first time in history, Mount Rushmore National Memorial exceeded the 1.5 million visitor mark, a 68-percent increase over 1955. During this same 10-year period, incidentally, Custer State Park recorded an average annual increase in visitation of about 20 percent.

Dependence on tourism.--Within the Black Hills area, there are several thousand residents who are largely dependent on tourism for a livelihood. The towns of Custer, Hill City, and Spearfish are heavily dependent on tourism, while Rapid City, Hot Springs, Deadwood, Lead, Sturgis, Wall, Sundance, Newcastle, and to a lesser extent Belle Fourche, would all find themselves in serious difficulty if they were to somehow lose their shares of this industry. Several other towns would be distinctly hurt by loss of the tourism industry. The economy would be only moderately set back by such a loss in some towns on the outer edges of the Hills area.

Several small summer "communities" in the central portion of the Hills, such as the highway-situated portions of Keystone and Rockerville, are so completely tourism-based that they nearly cease to operate in the off season. Fortunately, most cities and towns in the area have other industries and institutions which contribute to their economy and provide employment during the nontourist season. A unique example of summer tourism dependence in the area is the town of Spearfish. A very large portion of the tourist dollar spent there in the last 20 years has come from people who have driven there explicitly to see the nationally known Passion Play.

Importance of segments of the tourism industry.--Figures showing investment in, and income produced by, various segments of the tourist industry are lacking and difficult to obtain. Recent studies, however, have shed some light on how the out-of-state tourists spend their funds while in the area (graph 4).

GRAPH 4. HOW THE AVERAGE TOURIST DOLLAR IS SPENT
(FOR SOUTH DAKOTA AS A WHOLE AND OUT-OF-STATE VISITORS ONLY)



There is more investment in, and income produced by, the private sector than the public sector of the recreation-tourism industry. Both sectors, however, provide major impetus to the local economy, with the public sector providing the "resource base" upon which the entire recreation industry depends. Of distinctly tourist-oriented enterprises, the restaurant, motel-hotel-lodge, auto service stations, and paid-attractions categories appear to lead in income production, with would be only moderately set back by such a loss in some towns on the outer edges of the Hills area.

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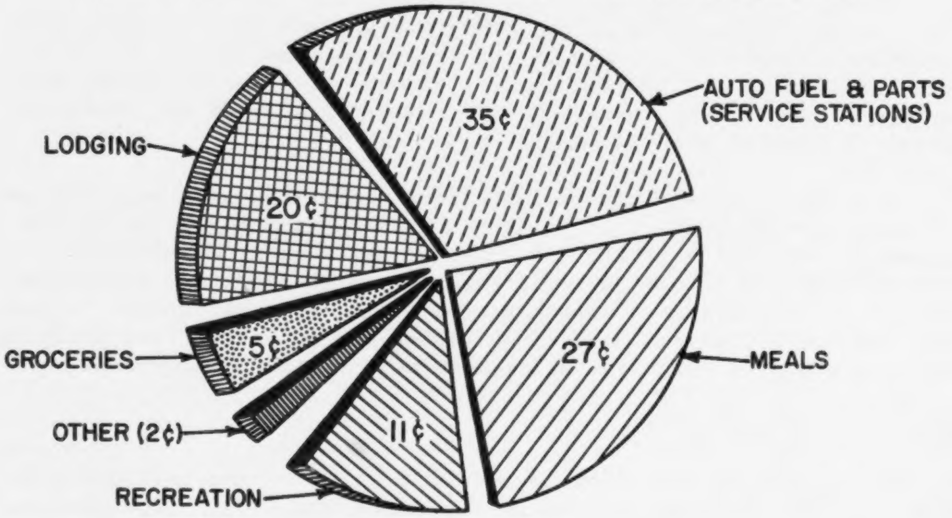

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There are many difficulties associated with the short-season, high-impact Black Hills tourist industry, but the continued "overflow" of tourists during peak periods of July and August stimulates an ever-increasing addition of new and better recreation facilities. And, the steady rise in income produced by the recreation industry continues. There is every reason to believe that attractions of the Black Hills will continue to draw greater numbers of tourists each year and will eventually help make tourism South Dakota's biggest industry.

FISH AND WILDLIFE

Fishing and hunting in the nine-county Black Hills area in 1964 contributed about $5 million to the area's economy by way of sportsman expenditures for lodging, meals, groceries, transportation, and equipment. Sportsman expenditures were estimated from the "National Survey of Fishing and Hunting, 1960."

Placing a dollar sign on these intangible resources measures only one aspect of their worth. The unmeasurable aesthetic value of the renewable fish and wildlife resources to the people of South Dakota, Wyoming, and the Nation may well exceed tangible monetary estimates. Countless thousands of people that don't fish or hunt, travel to the area and spend time and money just to see and photograph its wildlife. The area would be much less attractive without these resources.

Fish

Sport fishing.--In 1964 anglers from all over the United States spent 325,000 man-days fishing in the area (table 10). This fishery was worth more than $1.6 million in sportsman expenditures to the local economy.

A total of 45,000 fishing licenses was sold in the study area in 1964. About 62 percent of the licensed fishermen were residents and 38 percent were nonresidents. Resident fishermen spur the economy by their expenditures on boats, motors, and fishing gear and nonresidents by expenditures for meals, groceries, lodging, and transportation.

Table 10.—Fishing in lakes and streams, a nine-county area of the Black Hills of South Dakota and Wyoming, 1964

Item	Miles	Acres	Fisherman-days	Estimated fisherman expenditures 1/
Area totals				
Cold-water streams	203		43,664	$ 225,000
Warm-water streams	499		1,453	8,000
Cold-water impoundments		2,533	203,973	1,054,000
Warm-water impoundments		49,055	76,175	393,000
Cold-water fishermen			247,637	$1,279,000
Warm-water fishermen			77,628	401,000
Total	702	51,588	325,265	$1,680,000

1/ Estimates based on "1960 National Survey of Fishing and Hunting," U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.

Wyoming issues free fishing licenses to residents over 65 years of age who have lived at least 20 years in the State. Persons under 16 in South Dakota and 14 in Wyoming are not required to buy a fishing license. These groups represent a substantial portion of the total fishermen and are, for the most part, unaccounted for in fishing license sales data and economic estimates.

Commercial fishing.--There is no commercial fishing in the area; however, there are seven commercial fish farms or fee-fishing resorts (map 11).

Wildlife

Hunting and trapping.--It is estimated that wildlife hunter expenditures average about $3,230,000 annually (table 11). Trapping activity in the area has been relatively light because of a weak fur market. The fur catch is estimated at about 1,000 mink, the same number of beaver, and several thousand muskrats. Based on recent fur prices, this annual catch has a gross annual value of about $25,000.

Trends

Fishing pressure in the area probably will continue to increase. Man's influence probably will cause the loss of more trout streams and the creation of additional impoundments.

In general, the trend is expected to be one of increasing demand for hunting opportunities on a resource that is not expected to

Table 11.—Estimated annual values of wildlife resources (hunting only) —nine-county area, South Dakota and Wyoming, 1960-64 average

Species	Est. hunter expend. (av. spent per hunter) 1/	Total hunter expenditure
Deer 2/	$55.00	$1,595,000
Antelope	55.00	445,500
Elk 3/	55.000	53,350
Pheasant	(All but)	
Sharptail	(turkey)	
Ruffed grouse	($60 x)	
Sage grouse	(13,000)	780,000
Hun. partridge	(days)	
Rabbit 4/	( )	
Other 5/	( )	
Turkey	55.00	264,000
Waterfowl 6/	46.00	92,000
Total		$3,229,850

1/ Estimated Annual Average Expenditure, 1960 National Survey of Fishing and Hunting.

2/ Includes mule deer and white-tailed deer.

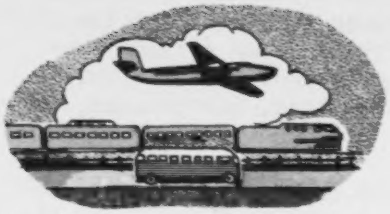
3/ Open seasons are occasional, not annual. In addition, 50 to 100 elk are harvested annually under a controlled hunt in Custer State Park.

4/ Jackrabbits and cottontails.

5/ Includes fox, coyote, raccoon, bobcat, prairie dogs, and woodchucks.

6/ Does not include waterfowl production value.

increase greatly in quantity. It is estimated that about 80 percent of the big game hunting is on public land and 20 percent on private land; about 40 percent of the upland game hunting is on public land and 60 percent on private land; about 20 percent of the waterfowl hunting is on public land and 80 percent on private land; and about 25 percent of the trapping activity is on public land and the remaining 75 percent on private land. The charging of hunting fees, primarily for big game, by private landowners is expected to increase. Although this practice adds directly to the economy of the community, it tends to reduce hunting for other game and thus may offset any benefits it may create.



OTHER FACTORS

Retail, Selected Services, and Wholesale Trades

Retail trade.--In 1963 there were 1,514 retail trade establishments in the Black Hills area with sales amounting to $191,652,000 and an annual payroll of $20,712,000. This was an increase of about 1 percent in number of establishments but an increase of about 25 percent in volume of business over that of 1958.

Selected services.--There were 1,065 establishments in the selected services trade group of the 1963 U. S. Census of Business for the area. Their 1963 sales amounted to $25,265,000 and their annual payroll totaled $5,670,000. This was an increase of 7 percent in the number of establishments and about 50 percent in volume of business over that for 1958.

Of the 1,065 service establishments in 1963, there were 325 hotels, motels, tourist courts and camps, 122 auto repair and service establishments, and 618 other service establishments.

Wholesale trade.--The area wholesale trade in 1963 included 252 establishments with a sales volume of $125,106,000 and a payroll of $7,736,000. This was about the same number of establishments as in 1958, but an increase of 16 percent in volume of business over that of 1958.

Summary of retail, selected services, and wholesale trades.--The total annual economic impact of the retail, selected services, and wholesale trades in 1963 is summarized as follows:

Number of establishments	2,831
Volume of business	$342,023,000
Annual payroll	$ 34,118,000

Transportation and Utilities

Transportation.--The Black Hills area is moderately well supplied with transportation facilities. It is serviced by three major railroad lines that provide freight service and a good network of U. S., State, and county hard-surfaced highways, including Interstate 90 which enters the eastern edge of the area and skirts along the northern edge of the Hills. Bus passenger service is available through most of the Hills area. Airline service is provided at Rapid City by three airline companies. Some of the smaller towns have small municipal airports which are utilized by local charter flying service companies, businessmen, and farmers and ranchers of the area.

Utilities.--Electrical service is available in adequate amounts to all towns and most farms and ranches of the area. Natural gas is available in Rapid City and smaller towns along the northern edge of the Hills in South Dakota and at Newcastle, Wyoming.

Manufacturers

In 1958 there were 155 manufacturing establishments in the Black Hills area. These establishments had about 2,450 employees and an estimated $8.9 million annual payroll. The estimated value added to products by manufacturing amounted to $14.8 million.

Data on the 1963 U. S. Census of Manufactures were not available for comparison with the 1958 data at the time this report was prepared.

Government

The 1960 U. S. Population Census showed a total of 7,706 civilian persons employed by the various governmental agencies in the Black Hills area. There were also 4,878 Armed Forces personnel stationed in the Black Hills area.

State institutions and facilities that have a significant impact on the economy of the area include: South Dakota School of Mines and Technology at Rapid City; Black Hills State College at Spearfish; State Soldiers Home at Hot Springs; State Hospital at Custer; State Cement Plant at Rapid City; Custer State Park; and other parks and facilities.

Federal institutions, agencies, and facilities that have a significant impact on the area include: Ellsworth Air Force Base at Rapid City; Sioux Sanatorium at Rapid City; Veterans Administration Hospital at Fort Meade; Veterans Administration Hospital at Hot Springs; U. S. Forest Service; National Park Service; and others.

Ellsworth Air Force Base is the largest of the Government facilities from the standpoint of employment and salaries. Nearly 5,900 officers and airmen were stationed at the base and civilian employees numbered about 500 in 1965. The annual payroll of Ellsworth Base totaled slightly over $30 million in 1965; about 75 percent or slightly over $22 million was expended in local retail and service establishments. Ellsworth Air Force Base, in fiscal year 1965, expended nearly $9.5 million through local purchase channels.

Twenty-five percent of revenues from national forest and national grassland grazing fees, timber sales, oil and gas leases, mineral leases and permits, recreation fees, and land use permits is distributed to State and county governments. Almost $90,000 was distributed to the States and counties in this area in fiscal year 1965 from such sources. On public domain, managed by the Bureau of Land Management, 50 percent of the grazing fees amounting to $19,000 in fiscal year 1965, 37.5 percent of the mineral leases, 5 percent of the timber sales, and 5 percent of the sale of land are returned to the counties.

Employment

The 1960 U. S. Population Census showed a total of 43,580 employed civilians in the Black Hills area. The class of employment for these people is shown in the following tabulation:

Class of worker	Agricultural employment	Nonagricultural employment	Total employment
Private wage and salary	1,419	25,215	26,634
Government	4	7,702	7,706
Self-employed	4,148	4,426	8,574
Unpaid family worker	325	341	666
Total	5,896	37,684	43,580

In addition to civilian employment shown above, there were 4,878 Armed Forces personnel in the Black Hills area in 1960.

Employment by the various industry groupings as shown by the U. S. Census for the years 1940, 1950, and 1960 is presented in table 12.

Income

Personal income in the Black Hills area increased by about 140 percent from 1950 to 1960. This compares with an increase of about 60 percent from 1950 to 1960 for the States of South Dakota and Wyoming.

Personal income for the Black Hills area for 1940, 1950, and 1960 was as follows:

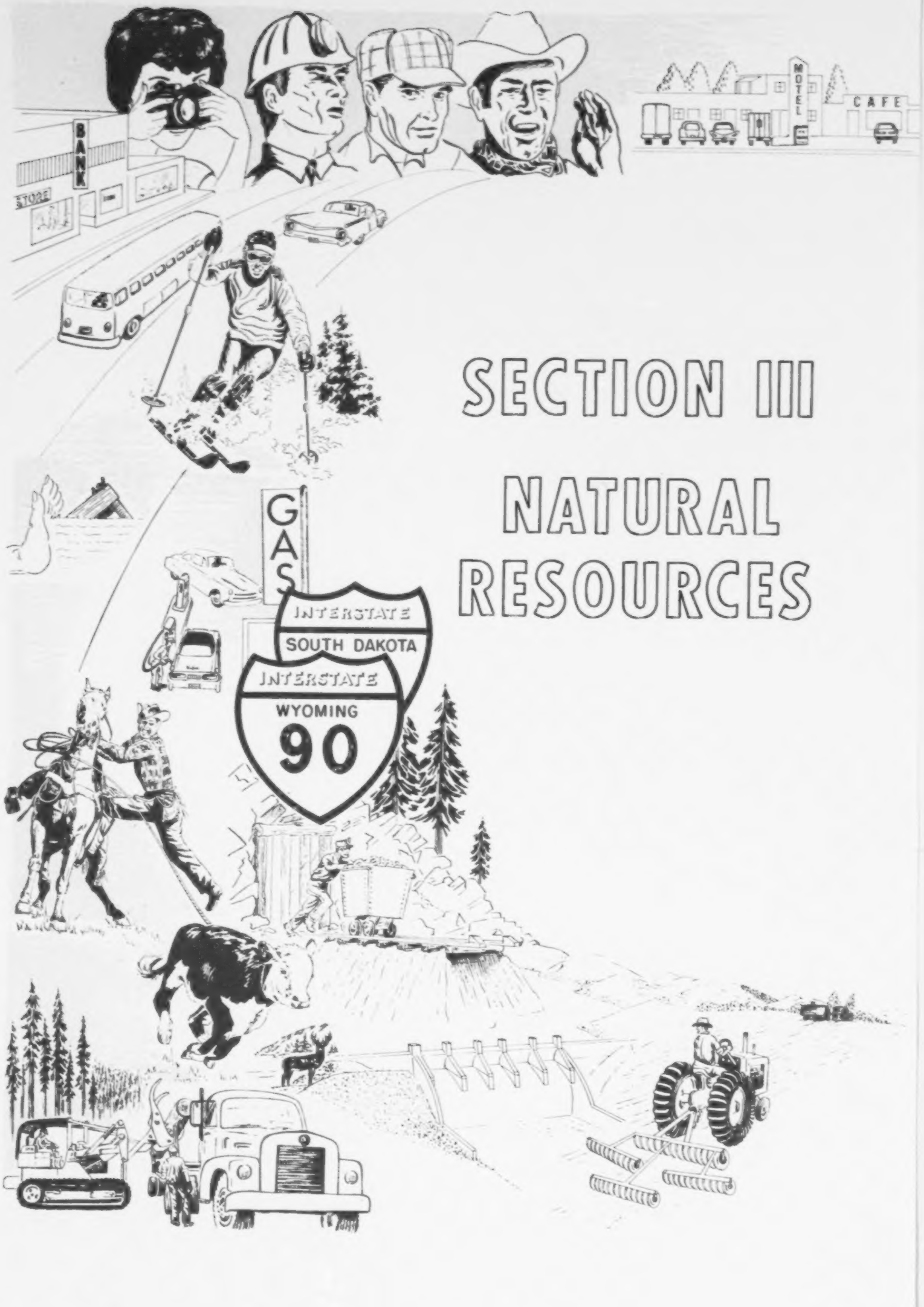
Year	Personal income
1940	$ 32,369,000
1950	107,441,000
1960	261,031,000

Estimated personal income for the Black Hills area, by industries, for 1960 is shown in table 12.

Table 12.—Employment by industry group, 1940, 1950, and 1960, and preliminary estimate of personal income for 1960, Black Hills area

Industry group	Employment 1940	Employment 1950	Employment 1960	Personal income 1960
				$ 1,000
Agriculture	8,584	8,165	5,896	22,737
Forestry and fisheries	69	152	185	599
Mining	3,174	3,063	2,723	12,505
Construction	1,477	2,820	4,239	32,733
Manufacturing	(2,196)	(2,442)	(3,478)	(14,011)
Food and kindred prod.	374	508	838	3,752
Textile mill products	7	9	11	38
Apparel and textile	16	11	8	19
Lumber and wood products	1,005	957	1,168	4,152
Printing and publishing	205	302	455	2,006
Chemical products	20	20	38	139
Electrical and mach.	53	88	86	311
Motor vehicles and equip.	4	6	16	60
Other transportation	3	14	192	686
Other manufacturing	509	527	666	2,848
Railroad and ry. exp. service	507	501	311	2,214
Trucking service and warehouse	410	521	778	5,547
Other transportation	101	276	298	2,094
Communications	188	442	683	3,946
Utilities and sanitary service	336	552	697	4,019
Wholesale trade	496	780	1,027	4,793
Food and dairy prod. stores	793	963	847	2,059
Eating and drinking places	831	1,479	1,857	3,132
Other retail trades	2,346	3,589	4,414	13,850
Finance, ins. and real estate	460	754	1,397	4,388
Hotels and services	1,109	1,451	1,735	3,946
Other personal services:				
Private households	766	703	1,257	2,855
Business and repair	691	1,116	960	3,138
Entertainment and recreation	275	295	326	504
Medical and professional	2,747	4,027	6,069	32,928
Public administration	1,068	2,449	3,017	14,009
Industry not reported	441	724	1,386	5,627
Armed Forces	200	2,782	4,878	29,100
Other income 1/	--	--	--	40,297
Total	29,265	40,046	48,458	261,031

1/ Property income and transfer payments, less social insurance payments.



SECTION III

NATURAL RESOURCES

PRESENT UTILIZATION, DEVELOPMENT AND MANAGEMENT OF THE NATURAL RESOURCES

This section of the report presents a brief analysis of the utilization, development and management of the Black Hills natural resources. Qualitative and quantitative descriptions are shown for each of the major resources, including land, water, agriculture, timber, minerals, recreation, and fish and wildlife. Some management problems also are discussed.

LAND

Landownership

The nine-county Black Hills area contains 13,107,840 acres. About 38 percent (5,054,080 acres) is in three counties in Wyoming, with the rest in South Dakota. Almost 74 percent (9,675,633 acres) is in private ownership. Federal agencies administer 2,632,201 acres, which is about one-fifth of the total. The remaining 800,006 acres (6 percent) is State owned. Agencies responsible for the public lands are shown in table 13; locations of these public lands are shown on map 3.

Table 13.—Public land administration (acres)

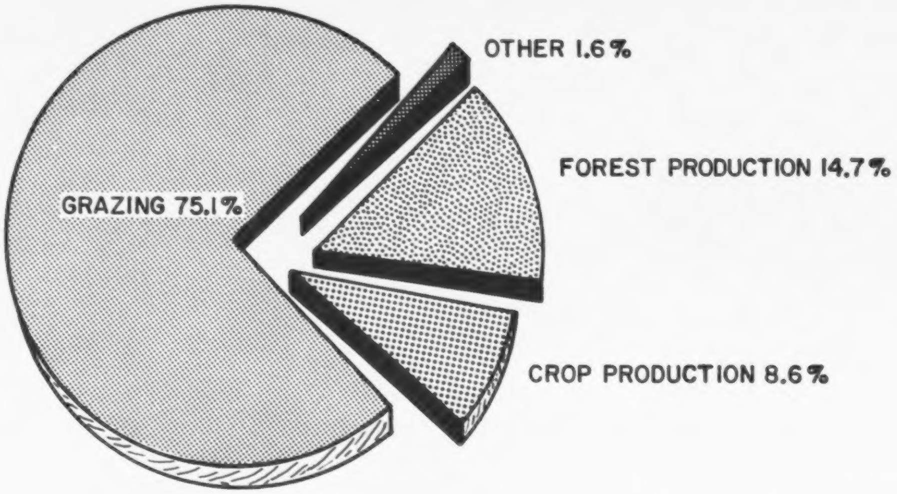
	Principal Federal Agencies			State Agencies (See footnotes)		
State	Forest Service	Bureau of Land Management	National Park Service	State Parks	State School Lands	Total
South Dakota	1,533,588	215,000	142,142	[a]75,075	[b]321,604	2,287,409
Wyoming	401,124	339,000	1,347	[c] 5,426	[d]397,901	1,144,798
Total	1,934,712	554,000	143,489	80,501	719,505	3,432,207

[a] Department of Game, Fish and Parks.
[b] Department of School and Public Lands.
[c] State Parks Commission.
[d] Commissioner of Public Lands.

Land Use

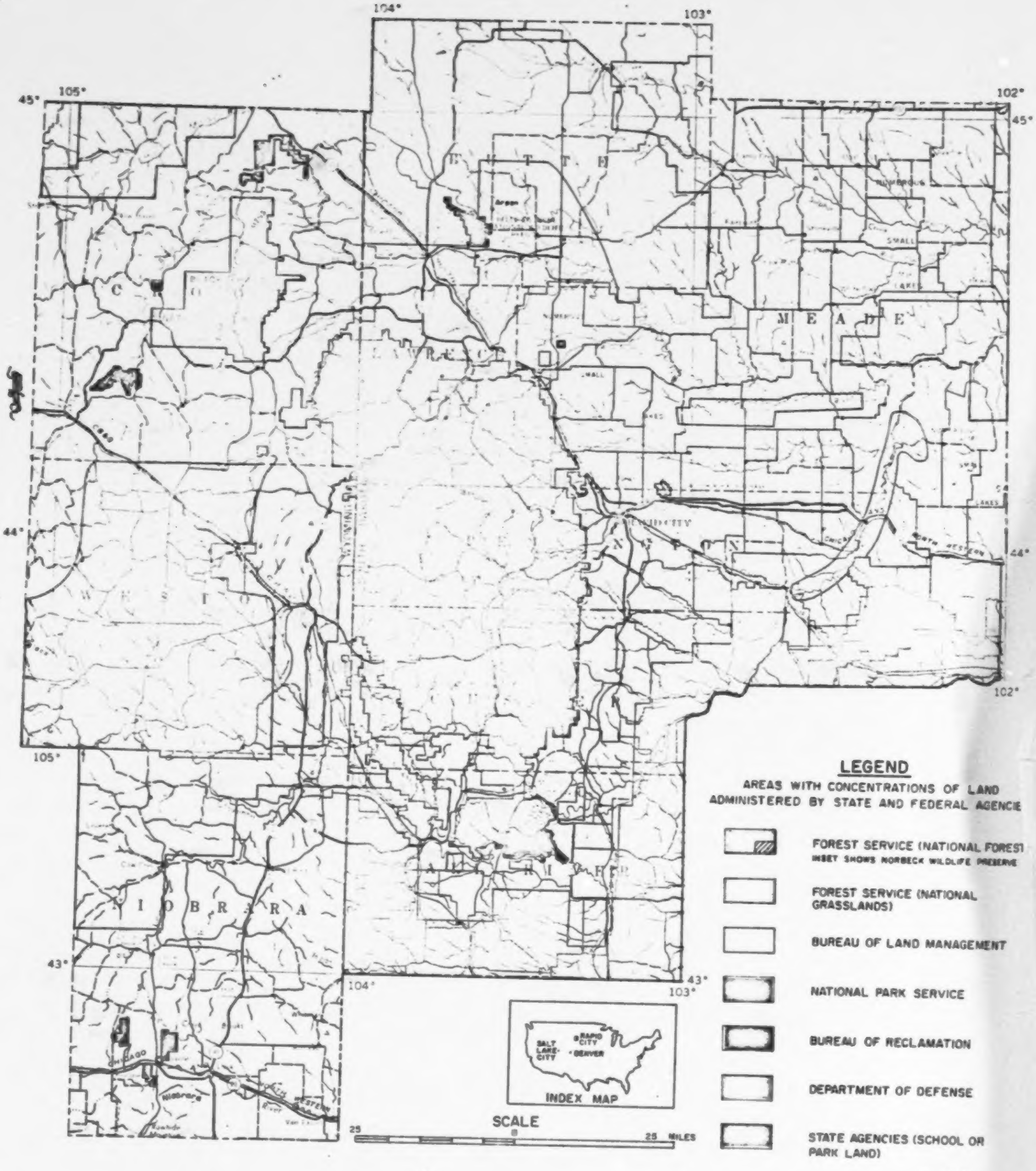
Land use can be divided into four broad categories: (1) Grazing, (2) crop production, (3) forest production, and (4) other. The percentage of each kind of land use in the Hills is shown in graph 5.

GRAPH 5. PRINCIPAL LAND USES



Grass is the principal vegetation on almost 10 million acres of the Black Hills area. About 7,881,000 acres is in private ownership (table 14). About 1,250,000 acres is administered by three Federal agencies: the Forest Service, Bureau of Land Management, and National Park Service. Most of the Forest Service areas are in the Thunder Basin National Grasslands in Wyoming and the Buffalo Gap National Grasslands in South Dakota; however, there are also scattered tracts of open rangeland in the Black Hills National Forest in both States. The Bureau of Land Management manages rangelands in each of the nine counties. Rangelands administered by the Forest Service and the Bureau of Land Management are used by ranchers for livestock grazing under Federal permit or lease procedures.

State agencies also manage some rangelands. In South Dakota, the Department of Game, Fish and Parks reserves about 16,000 acres in Custer State Park for grazing by big game. State agencies in Wyoming control almost 400,000 acres. Most of this is School Land. South Dakota, too, has a large amount of School Land—about 320,000 acres. In both States, such land is leased to farmers and ranchers for livestock grazing.


104°
103°
105°
45°
102°
45°
BUTTE
MEADE
LAWRENCE
WESTON
NIOBRARA
44°
44°
102°
105°
43°
43°
104°
103°
LEGEND
AREAS WITH CONCENTRATIONS OF LAND
ADMINISTERED BY STATE AND FEDERAL AGENCIE
FOREST SERVICE (NATIONAL FOREST
INSET SHOWS NORBECK WILDLIFE PRESERVE
FOREST SERVICE (NATIONAL GRASSLANDS)
BUREAU OF LAND MANAGEMENT
NATIONAL PARK SERVICE
BUREAU OF RECLAMATION
DEPARTMENT OF DEFENSE
STATE AGENCIES (SCHOOL OR PARK LAND)
SALT LAKE CITY
RAPID CITY
DENVER
INDEX MAP
SCALE
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25 MILES

MAP 3. PUBLIC LANDS

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See following page
for greater detail.
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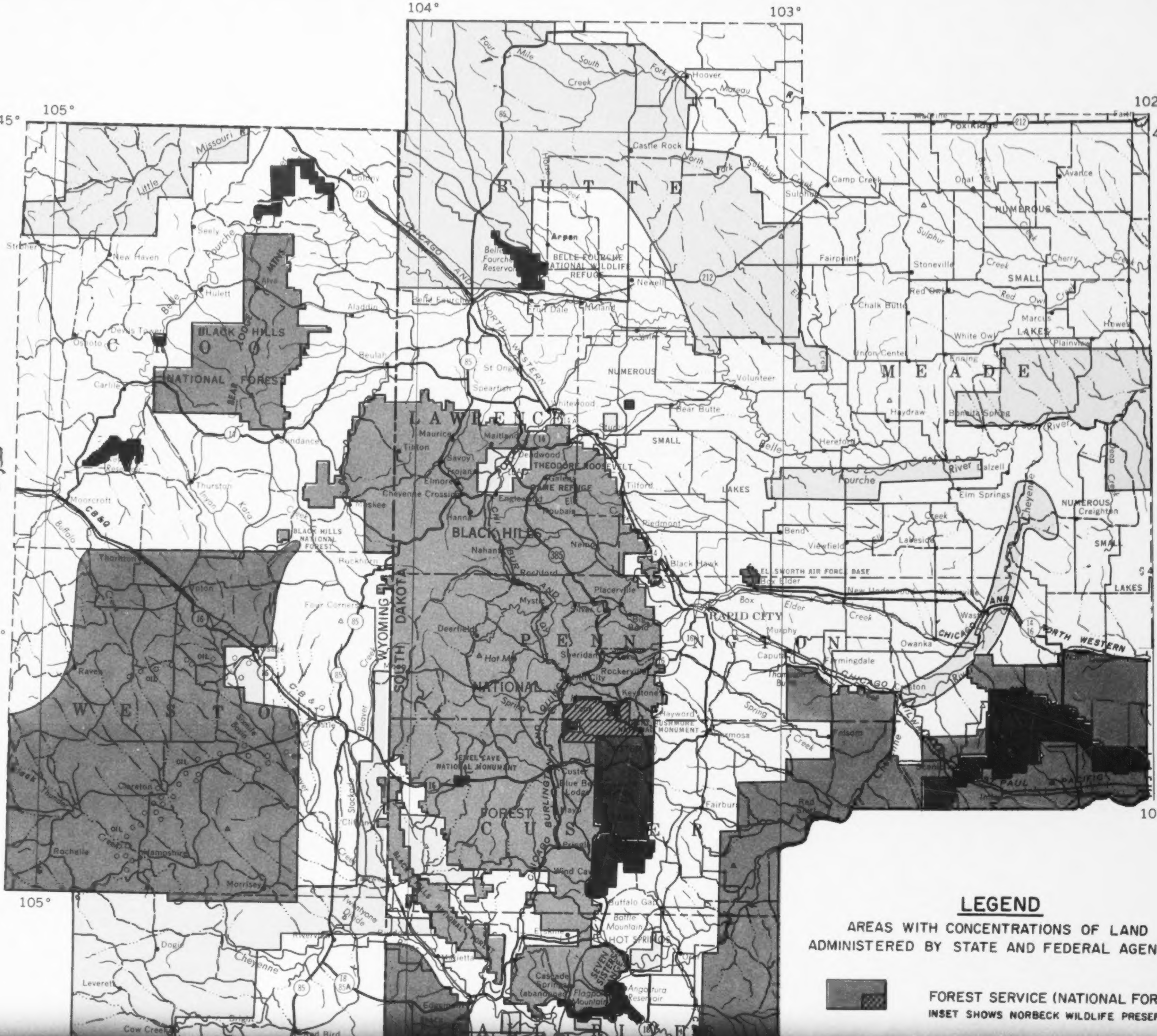


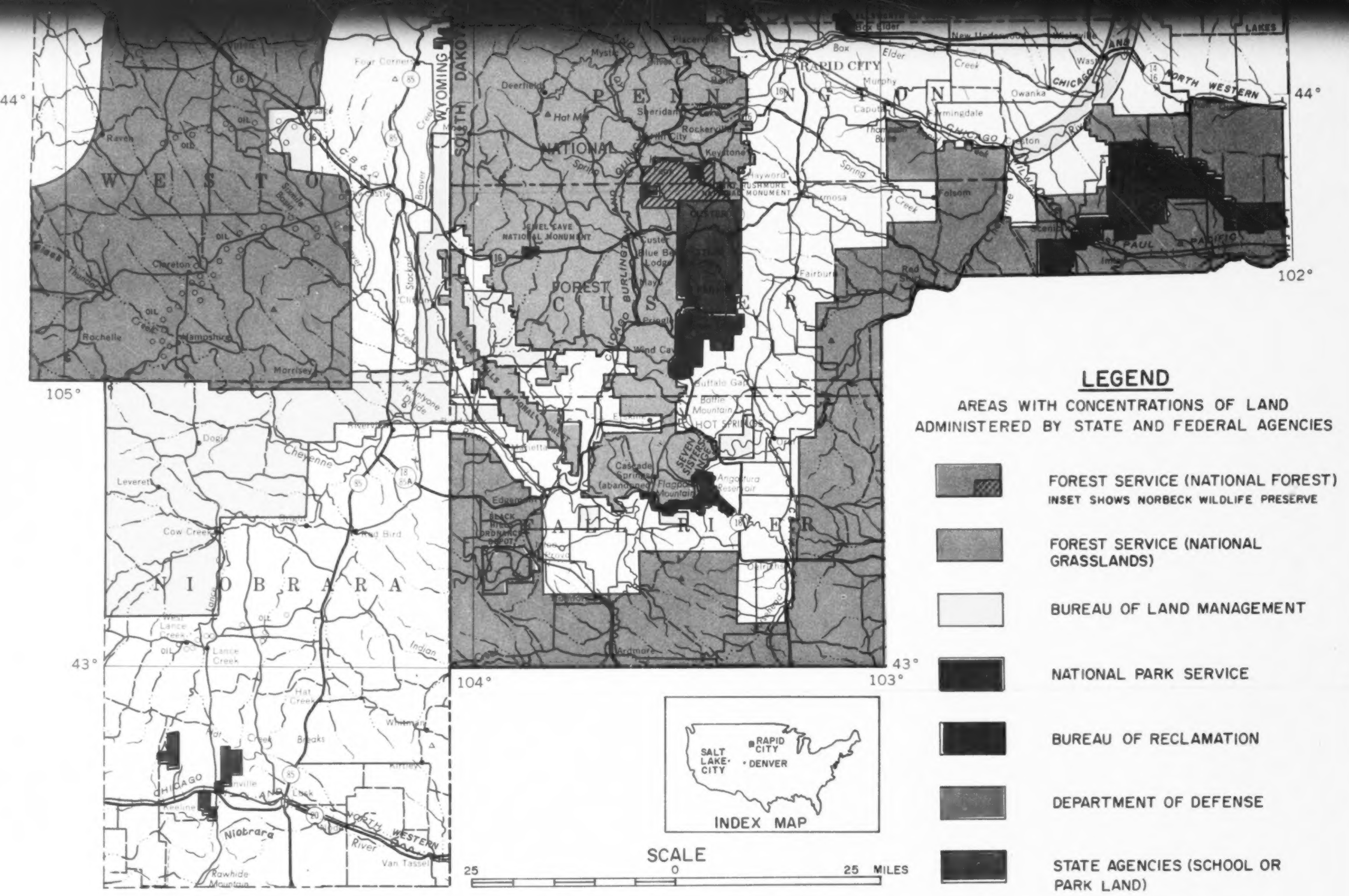
56a

LEGEND

AREAS WITH CONCENTRATIONS OF LAND
ADMINISTERED BY STATE AND FEDERAL AGENCIES

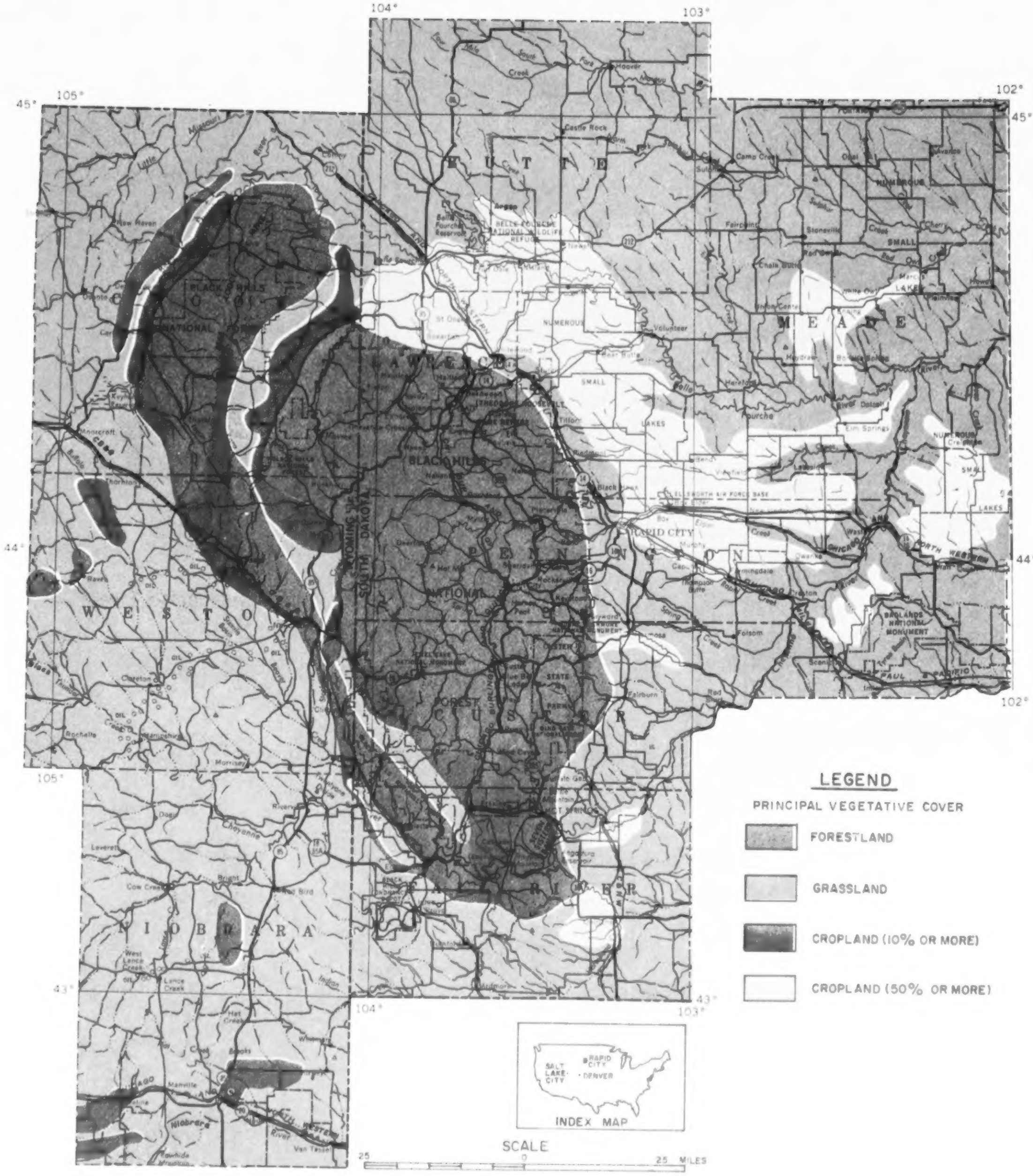
▨ FOREST SERVICE (NATIONAL FOREST)
INSET SHOWS NORBECK WILDLIFE PRESERVE

■



MAP 3. PUBLIC LANDS

B



MAP 4. PRINCIPAL LAND USE AREAS

Table 14.—Principal land use a/

	GRASS					CROP				
State	Private	Federal			State	Private	Federal			State
		BLM	FS	NPS b/	Park&school		BLM	FS	NPS	Park&school
S. Dak.	4,642,454	206,000	461,099	66,438	347,838	838,644	-	328	-	-
Wyo.	3,238,206	303,000	217,920	243	356,780	283,191	-	0	-	5,747
Total	7,880,660	509,000	679,019	66,681	704,618	1,121,835	-	328	-	5,747

GRAND TOTAL - 9,839,978 or 75.1%

GRAND TOTAL - 1,127,910 or 8.6%

	FOREST AND WOODLAND					OTHER				
State	Private	Federal			State	Private	Federal			State
		BLM	FS	NPS b/	Park&school		BLM	FS	NPS b/	Park&school
S. Dak.	215,683	9,000	1,047,678	9,509	43,841	69,579	-	24,483	66,195	-
Wyo.	341,945	36,000	183,204	947	40,800	45,940	-	-	157	-
Total	557,628	45,000	1,230,882	10,456	84,641	115,510	-	24,483	66,352	-

GRAND TOTAL - 1,928,607 or 14.7%

GRAND TOTAL - 206,345 or 1.6%

a/ Conservation Needs Inventory (1960).
b/ Non-consumptive uses only.

Nearly 2 million acres is classified as forestland. More than half of these lands are capable of growing commercial timber. The areas classified as noncommercial timberland are used mostly for livestock grazing. The Forest Service administers about 1,230,000 acres or 60 percent of all the timberland in the area. Most of this acreage is in the Black Hills National Forest. The Bureau of Land Management administers about 45,000 acres of timberland, and about 600,000 acres is privately owned.

Nearly all of the 1,127,900 acres of cropland in the Hills area is privately owned; about three-fourths, or 838,600 acres, is in South Dakota.

The 1959 Agricultural Census showed that about 646,000 acres or 57 percent of the total cropland was harvested. The balance was being used as rotation pasture or was not harvested. The acres not harvested were in cultivated summer fallow, in soil improvement crops, idle, or in areas where the crop failed.

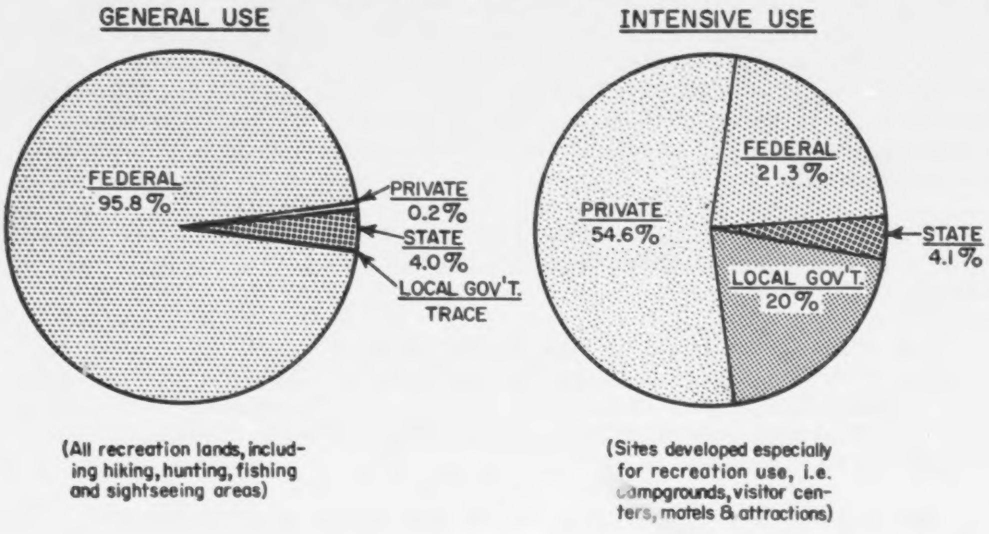
About 206,000 acres is in other uses. Lands in urban areas, roads, and areas without vegetative cover in the Badlands National Monument are included in this category.

Mineral resources are found on all types of lands. About 65,000 acres is now being used for commercial mineral production. In ordinary mining, land occupancy includes excavation areas, stock and waste piles, access roads, and milling activities. Land occupancy on petroleum leases includes pump installations, treaters, tank batteries, and access roads. It is estimated that limestone mining annually depletes 20 acres of surface values, and bentonite mining 210 acres.

More than 95 percent of the land in the nine-county area is valuable for wildlife habitat, and about 2,232,000 acres is considered to have special values for recreation pursuits of one kind or another, such as camping, picnicking, hunting, and fishing. Many of these activities take place on lands classified and used for other primary resource production purposes. Slightly more than 6,400 acres has been intensively developed for recreation. Graph 6 shows the percentage of public and private lands used for general or intensive recreation.

Almost every acre of land receives some degree of multipurpose use. Approximately 680,000 acres of Forest Service land, as an example, is classified as rangeland but more than 1,141,000 acres is actually grazed. This is because about 461,000 acres classified as timberland is used for grazing as well as wood production.

GRAPH 6. HOW RECREATION LANDS ARE USED



(All recreation lands, including hiking, hunting, fishing and sightseeing areas)

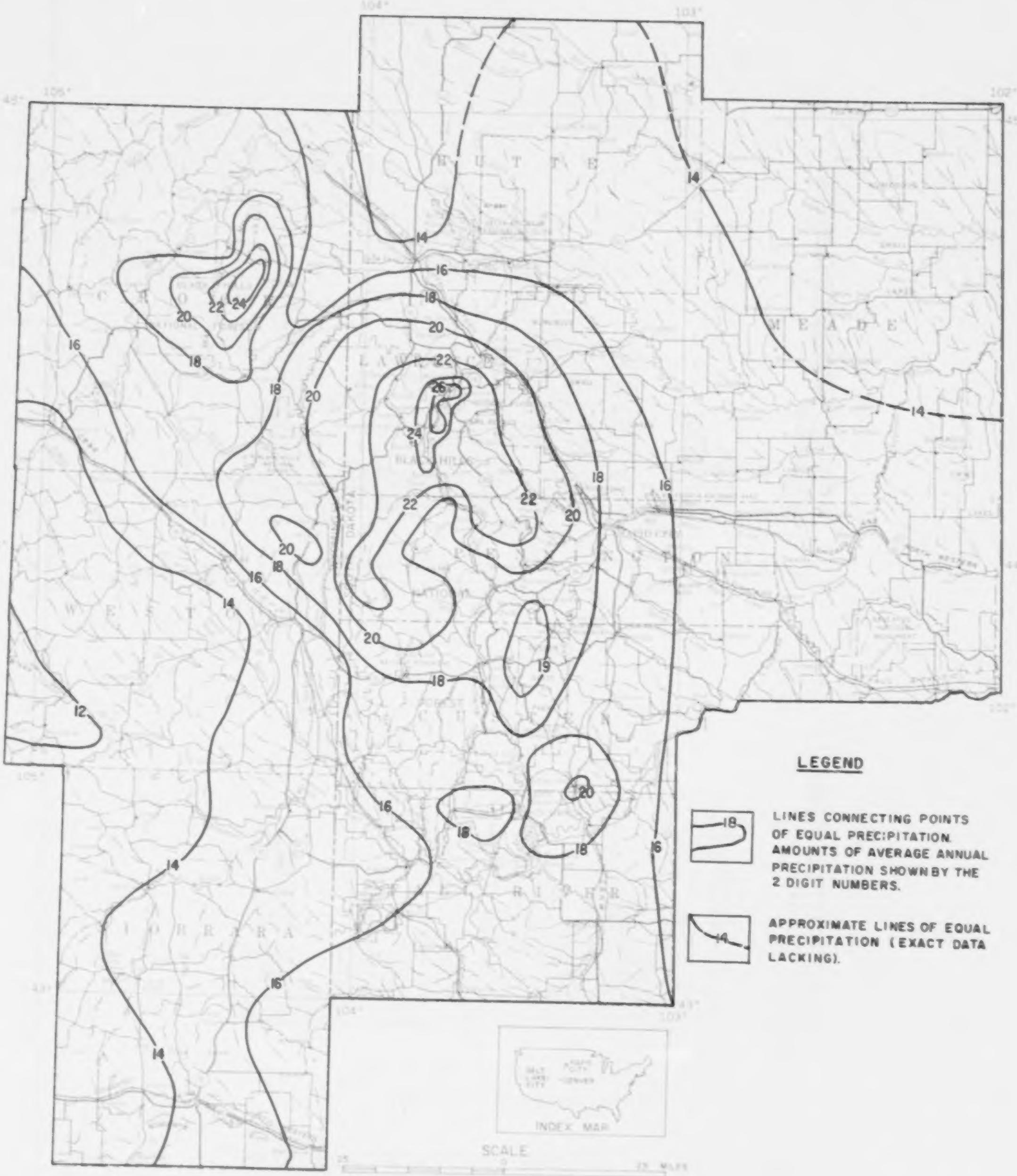
(Sites developed especially for recreation use, i.e. campgrounds, visitor centers, motels & attractions)

WATER

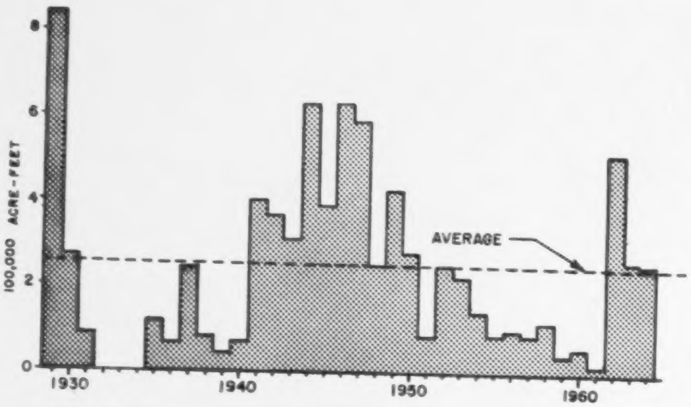
Surface Water

Average annual precipitation ranges from a low of about 12 inches on the plains in the western part of the Black Hills area to a maximum of about 28 inches at the higher mountain elevations in the northern Hills. At comparable elevations, annual precipitation is generally greater in the northern Black Hills than in the southern Hills (map 5). Winter precipitation is also greater in the north, which usually results in a much heavier snowpack in that area.

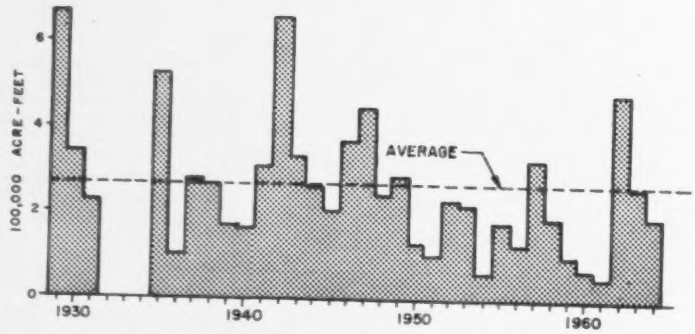
The Black Hills area is drained by the Cheyenne River and its major tributary, the Belle Fourche River (map 6). The Belle Fourche River rises in the gently rolling plains area to the west of the Hills and flows around their northern margin. The Cheyenne also heads on the plains of Wyoming, in the area just to the south of the headwaters of the Belle Fourche River, and flows around the southern margin of the Hills. The two rivers join on the prairies of western South Dakota about 85 miles east of the South Dakota-Wyoming state line. Thence, the Cheyenne flows generally eastward to the Missouri River. Both rivers have highly variable streamflows (graph 7). The average annual


BUTTE
MEADE
CROOK
LAWRENCE
PENNINGTON
WESTON
CUSTER
FALL RIVER
NIOBRARA
LEGEND
LINES CONNECTING POINTS OF EQUAL PRECIPITATION. AMOUNTS OF AVERAGE ANNUAL PRECIPITATION SHOWN BY THE 2 DIGIT NUMBERS.
APPROXIMATE LINES OF EQUAL PRECIPITATION (EXACT DATA LACKING).
INDEX MAP
SCALE

MAP 5. ISOHYETAL MAP OF AVERAGE ANNUAL PRECIPITATION



BELLE FOURCHE RIVER NEAR ELM SPRINGS, S. DAK.
DRAINAGE AREA = 7,210 SQ. MI.



CHEYENNE RIVER NEAR WASTA, S. DAK.
DRAINAGE AREA = 2,000 SQ. MI.

GRAPH 7. YEARLY STREAMFLOW (RUNOFF) CHEYENNE RIVER NEAR WASTA, S.D., AND BELLE FOURCHE RIVER NEAR ELM SPRINGS, S.D. (SEE MAP 6) flow of these two streams for the period shown on graph 7 was 522,000 acre-feet. The combined flow represents the surplus water available for additional development in the study area.

Almost all streams draining the prairie lands surrounding the Black Hills flow only in direct response to rainfall or snowmelt; their channels are dry for long periods in most years. In contrast, many of the streams in the mountainous area are perennial. Average annual runoff from the Hills is considerably greater than from the surrounding prairie.

Variation in precipitation is the major cause of year to year fluctuation in streamflow in the Belle Fourche and Cheyenne Rivers. Periods of high and low precipitation are clearly reflected in the streamflow records of the area. Though monthly variations in runoff for the mountain streams are much smaller than in prairie streams, flows from both areas follow the general precipitation pattern and are greatest in the period of April through July. June is the month of maximum precipitation, but runoff is maximum in May for many of the mountain streams. This is due to the spring snowmelt and to greater evaporation and utilization of moisture by vegetation in June than in the earlier months of the growing season (graphs 8 and 9).

In the Cheyenne basin above Angostura Reservoir, it is estimated that there are more than 9,300 small reservoirs or stockwater ponds having a total capacity of about 60,000 acre-feet. The magnitude of downstream flows withheld by these reservoirs ranges from 19,000 acre-feet in a dry year up to 80,000 acre-feet in a very wet year. The numerous small reservoirs in the Cheyenne basin below Angostura Dam and in the Belle Fourche basin have a similar effect.

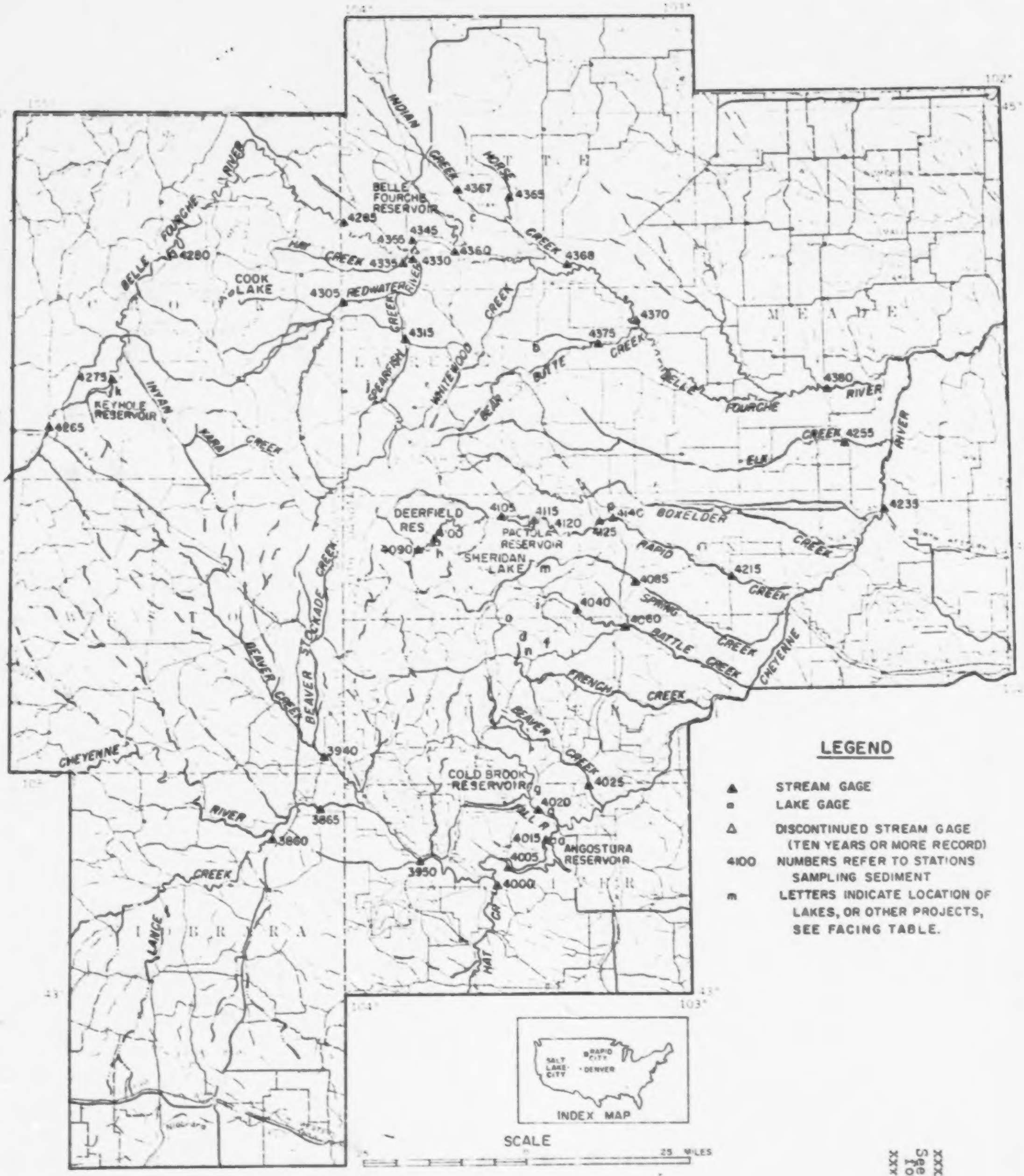
Geology has a major effect on surface water yield from the Black Hills. The Hills consist of a central area of crystalline rocks surrounded by the tilted outcrop belts of sedimentary formations. Records of deep wells show that these formations underlie the plains for long distances to the east, north, and south.

Bedrock formations in the central crystalline area, for the most part, are relatively dense and impervious to water. This area is the main source of sustained flow in many streams. The generally excellent vegetative cover, whether forest or grass, and the highly organic soils in most areas are conducive to rapid infiltration of moisture that reaches the ground. This combination of relatively impervious bedrock, rapid infiltration and greater total precipitation in the central area results in the maintenance of return flows from ground water even in dry seasons. Springs and seeps, where ground water comes to the surface, are common and their flow has been sustained by numerous beaver ponds, artificial ponds, and reservoirs. There are no reports of water loss from any of the streams in the crystalline area other than from natural evaporation.

Table 15.—Artificial impoundments and flood control structures

Map symbol	Name	Surface area (acres)	Storage (usable capacity in acre-feet)	Use
a	Angostura Reservoir	4,830	136,300	Irrigation, flood control, recreation
b	Bear Butte Lake	193		Recreation
c	Belle Fourche Reservoir	8,040	185,200	Irrigation, recreation
d	Bismarck Lake	22		Recreation
e	Canyon Lake	37		Recreation
f	Center Lake	25		Recreation
g	Cold Brook Reservoir	35		Flood control, recreation
h	Deerfield Reservoir	414	15,150	Irrigation, recreation, municipal water
i	Horse Thief Lake	20		Recreation
j	Iron Creek Lake	23		Recreation
k	Keyhole Reservoir	9,420	199,900	Irrigation, flood control, recreation
l	Pactola Reservoir	860	55,800	Flood control, irrigation, recreation, municipal water
m	Sheridan Lake	395	12,660	Recreation
n	Stockade Lake	127		Recreation
o	Sylvan Lake	17		Recreation
p	Red Dale Project	NA		Flood control
q	Fall River Project	NA		Flood control
r	Cook Lake	28		Recreation

64a



MAP 6. RESERVOIRS, LAKES, GAGING STATIONS AND MAJOR DRAINAGE P ERNS

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for greater detail.
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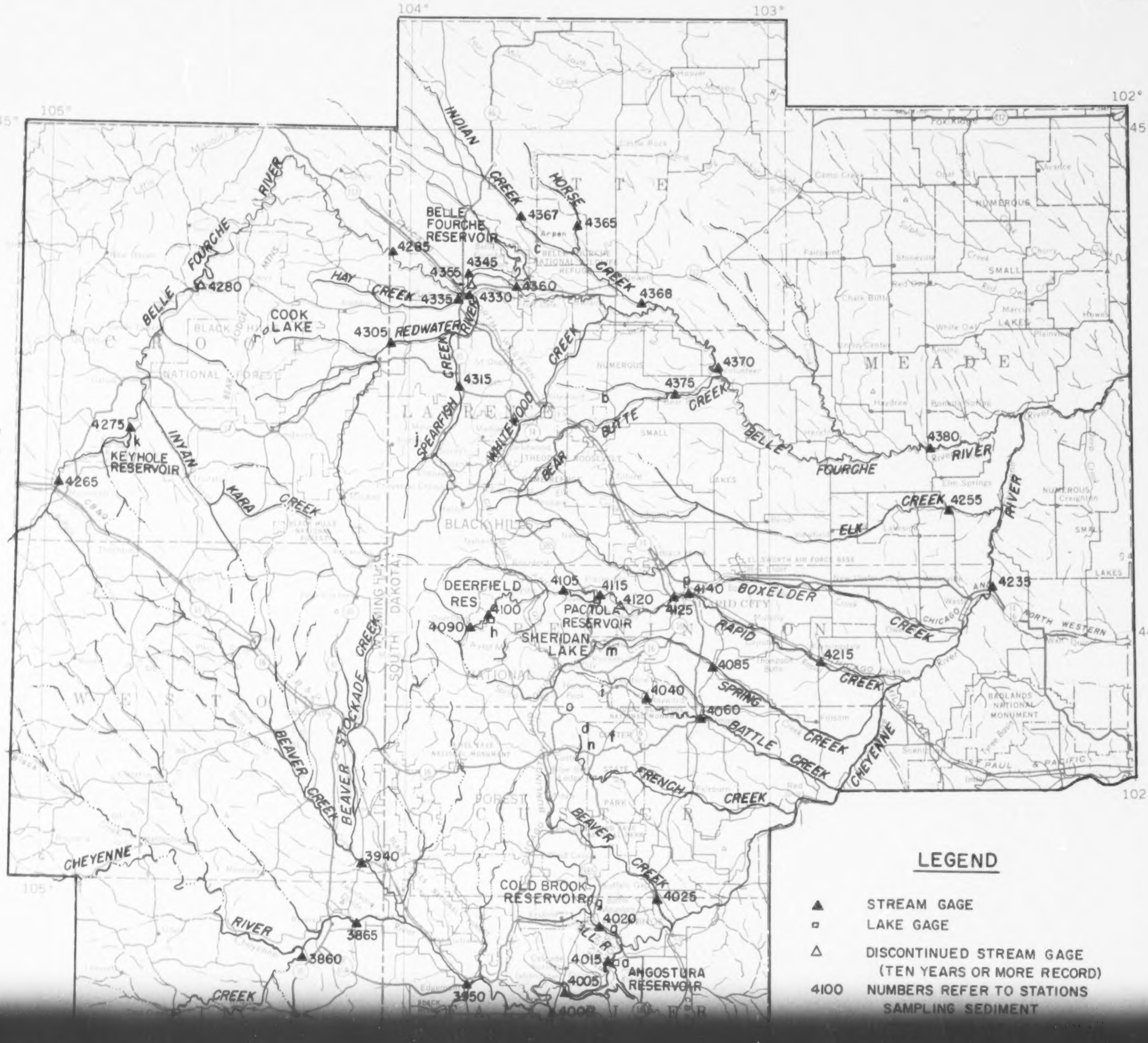
LEGEND
▲ STREAM GAGE
▫ LAKE GAGE
△ DISCONTINUED STREAM GAGE (TEN YEARS OR MORE RECORD)
4100 NUMBERS REFER TO STATIONS SAMPLING SEDIMENT
104°
103°
102°
105°
45°
44°
BELLE FOURCHE RIVER
INDIAN CREEK
HORSE CREEK
BELLE FOURCHE RESERVOIR
HAY CREEK
REDWATER RIVER
COOK LAKE
SPEARFISH CREEK
WHITEWOOD CREEK
BEAR BUTTE CREEK
ELK CREEK
BOXELDER CREEK
RAPID CREEK
SPRING CREEK
BATTLE CREEK
FRENCH CREEK
BEAVER CREEK
CHEYENNE RIVER
STOCKADE BEAVER CREEK
KARA CREEK
INYAN KARA CREEK
KEYHOLE RESERVOIR
DEERFIELD RES
PACTOLA RESERVOIR
SHERIDAN LAKE
COLD BROOK RESERVOIR
ANGOSTURA RESERVOIR
BUTTE
MEADE
LAWRENCE
PENNINGTON
CUSTER
CROOK
WESTON
BLACK HILLS
WYOMING
SOUTH DAKOTA
RAPID CITY
BADLANDS NATIONAL MONUMENT
4367
4365
4285
4345
4355
4360
4335
4330
4368
4280
4305
4370
4375
4315
4380
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3940
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3865
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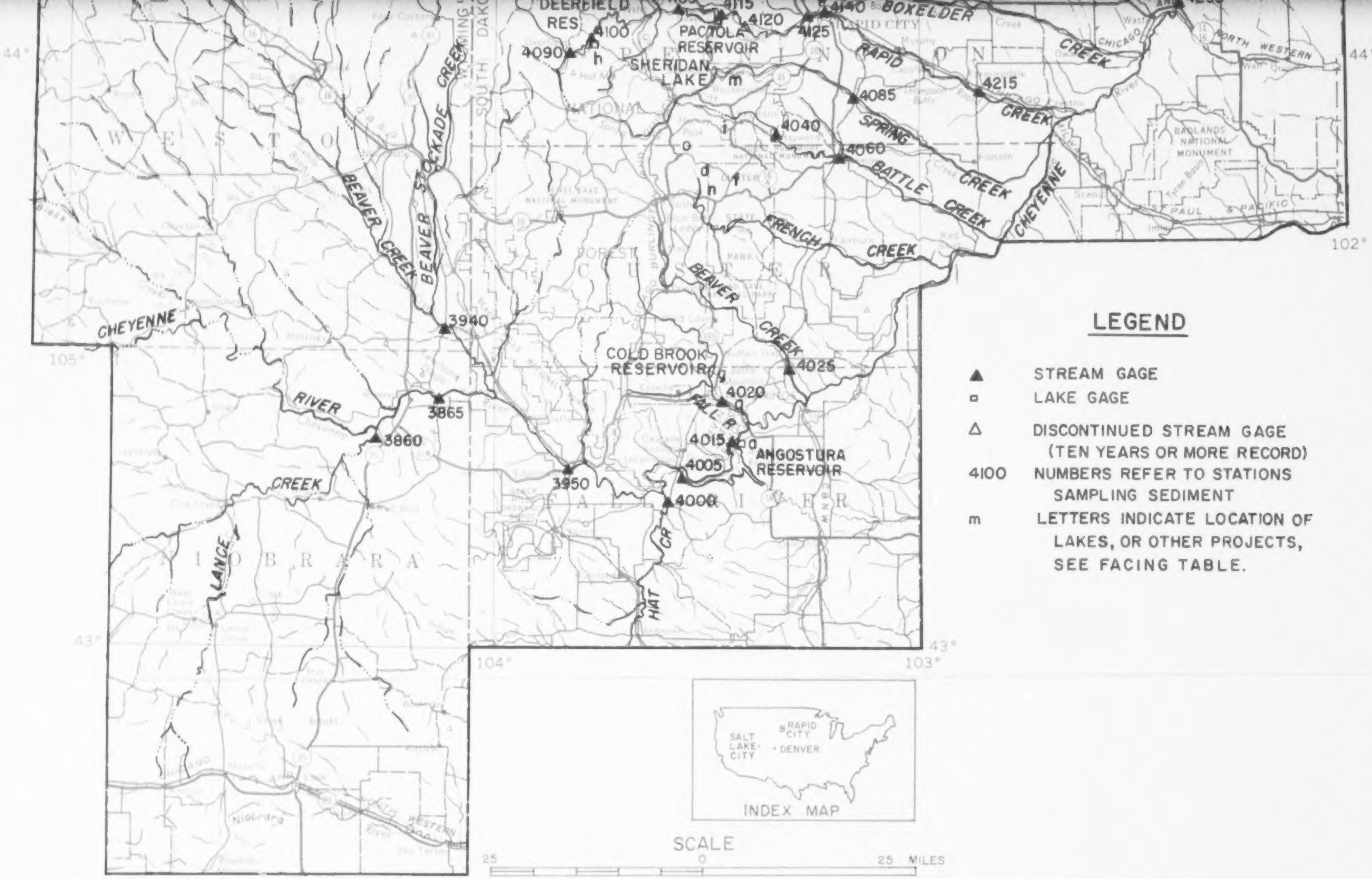
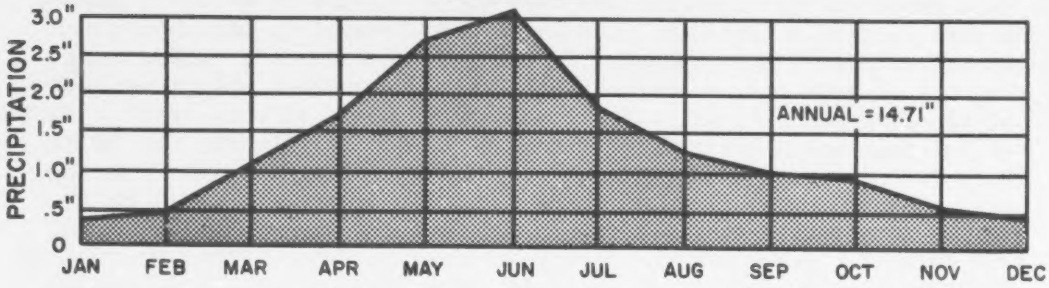


MAP 6. RESERVOIRS, LAKES, GAGING STATIONS AND MAJOR DRAINAGE PATTERNS

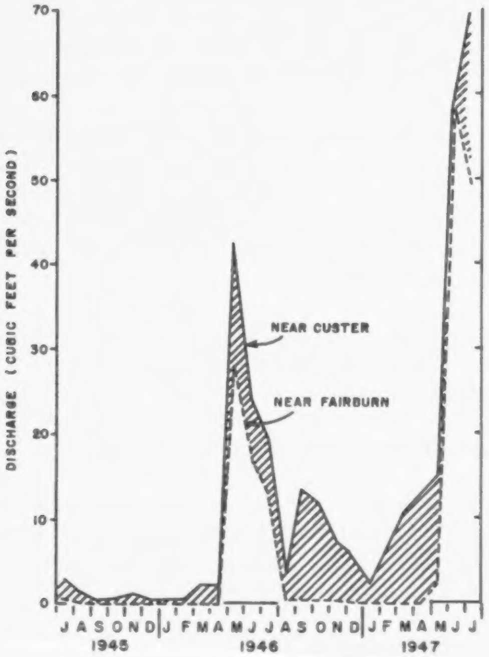
B

GRAPH 8. AVERAGE DISTRIBUTION OF PRECIPITATION

RAPID CITY



GRAPH 9. LOSS OF FRENCH CREEK TO SINKHOLES



MONTHLY STREAMFLOW FRENCH CREEK NEAR CUSTER, S. DAK. (DA 98 SQ MI) AND NEAR FAIRBURN, S. DAK. (DA 129 SQ MI) SHADED AREA INDICATES LOSS OF FLOW BETWEEN STATIONS

Most Black Hills streams originating in the central crystalline area flow generally eastward more or less at right angles across the outcrops of the sedimentary formations. From early times, residents have observed that some streams lose large volumes of water in passing across certain formations. The water was observed to disappear into cavities, caves, and sinkholes in the massive limestone cliffs bordering the streams and, by percolation, into the boulder and gravel beds of the streams. The principal losses occur where streams cross outcrops of the Pahasapa Limestone and Minnelusa Formation. During the period July 1945 to July 1947, pairs of gaging stations were operated on several streams to gather data on the magnitude of the losses to these sedimentary formations. The maximum measured loss between the Custer and Fairburn, South Dakota, gaging stations on French Creek occurred in 1947; it was 100 percent or about 14 cubic feet per second (graph 9).

There are few natural lakes in the area, but many artificial impoundments have been constructed (map 6). The prairie lands and foothills of the Black Hills are dotted with thousands of small reservoirs which store intermittent streamflow to provide water for livestock, fish and wildlife and, in some cases, minor irrigation. Supplies for major irrigation are stored in Angostura Reservoir on the Cheyenne River; Deerfield and Pactola Reservoirs in the Rapid Creek basin; and Keyhole and Belle Fourche Reservoirs in the Belle Fourche River basin. Belle Fourche Reservoir is located off-stream but receives the entire flow of the Belle Fourche River by diversion except when the flow exceeds the capacity of the diversion canal or when the reservoir is full.

More than 125 floods have occurred in the last 88 years along the main stem and tributaries of the Cheyenne River. In 1879, a sudden cloudburst caused a flash flood on Beaver Creek, South Dakota, that drowned eleven members of a wagon train camped along its bank. Since then, there have been 70 lives lost in the Cheyenne River basin that could be attributed to floods.

Most floods occur during May and June as a result of heavy general or localized rains. The steep gradient streams dump their floodwaters swiftly onto the overflow areas, carrying tons of boulders and mountain debris that add to the damaging effects. Flood peaks are of short duration, rarely extending beyond a few hours.

Reconnaissance data collected by SCS indicate that about 308,000 acres is subject to flooding along the principal tributaries and rivers. A high percentage of this flooding is on grassland, but a significant part of the damages is on cropland and urban areas.

The flood of 1965 exemplifies the history of flooding in this basin. Extremely heavy rainfall, beginning on May 14, 1965, accelerated snowmelt of a 32-inch snow that had preceded the rainfall by one week. Extensive flooding developed on Bear Butte Creek, Spearfish Creek, and Whitewood Creek. Minor lowland flooding occurred on Beaver Creek, Bear

Creek, False Bottom Creek, and Redwater River. Urban damage occurred at Sturgis, Deadwood, Spearfish, Belle Fourche, Central City, Lead, and several smaller communities. The total urban damage was about $1.7 million. Rural area damages were quite extensive throughout the basin. About 3,600 acres was flooded, with damages estimated to be over $2.6 million.

The Corps of Engineers is now conducting a multiple-purpose water supply study, including flood control and allied water uses, in the Cheyenne and Belle Fourche River basins above the confluence of the two streams. This study, scheduled for completion in 1968, should provide additional information on the flood problem that will be helpful in its solution.

A major function of four water resources projects in the Black Hills area (map 6) is the control of floods. The Corps of Engineers has constructed three of these projects:

1. The Belle Fourche Project for protection of Belle Fourche, South Dakota, consists of an earth levee, a concrete retaining wall and a riprap blanket along the right bank of the Belle Fourche River. The project was completed in 1939.

2. The Red Dale Gulch Project for protection of the suburban Red Dale Gulch area of Rapid City consists of a small earthfill dam, which was completed in 1959.

3. The Fall River Project consists of a channel improvement through Hot Springs, completed in 1950; a 130-foot high dam on Cold Brook which was completed in 1953, and an authorized dam on Cottonwood Creek which is in final design stage.

The Bureau of Reclamation has constructed one multipurpose structure with some flood control capacity—Pactola Dam. This earth-and-rockfill structure on Rapid Creek about 15 miles west of Rapid City was completed in 1956.

Ground Water

Not all of the rock units discussed here are water-bearing everywhere in the Hills area. Each unit, however, contains sufficient water at most locations where it occurs to be considered a source of water. Generally, the only area where ground water is unavailable or is available only in quantities of less than 10 gallons per minute from individual wells is the Precambrian "inner core" of the Black Hills. Elsewhere, except in the area of outcrop, most or all of the aquifers are present at varying depths.

The Deadwood Formation crops out around the Precambrian rocks in the Black Hills and underlies a large area north and east of the Hills; it is less extensive in the western and southern parts of the area. Water has been obtained from wells completed in the Deadwood Formation at or near its outcrop area in the Black Hills.

Sandstone and shale of the Winnipeg Formation overlie the Deadwood Formation in the northern Black Hills. Although the Winnipeg has not been developed, the formation is believed to have a high potential as a source of saline ground water.

The Pahasapa (Madison) Limestone crops out in an extensive area and is present in the subsurface over most of the nine counties. Streams that cross it lose all or part of their water to the formation. Much of the recharge to the subsurface Madison Group is accomplished in this manner, and yields from wells are dependent on the presence of solution channels, fissures and caverns without which the formation is dense and relatively impermeable. Fortunately, the areas in which the formation is most productive are those in which it is most accessible—along the northwestern margin of the Black Hills uplift where the beds are steeply upturned and likely to be fractured. The Pahasapa is not utilized extensively as a source of water for wells in South Dakota because water can usually be obtained more economically from the overlying Minnelusa Formation.

The Minnelusa Formation is the predominant aquifer in the area and could probably supply more water than it does at present (1966).

The Sundance Formation generally will yield water supplies adequate only for stock and domestic use, but, except for possibly the Hulett Sandstone near its center, will yield little more. Only a few wells are known to tap the Sundance Formation, and the salinity of its water increases rapidly away from the Hills.

The Inyan Kara Group comprising the Lakota and Fall River Formations is a principal source of stock and domestic water on the northern and western flanks of the Hills. Some wells flow as much as 150 gpm, but generally flows are small, ranging from 1 to 10 gpm.

The Newcastle Sandstone yields small supplies of saline ground water in Wyoming, and its potential in South Dakota appears to be low.

The Fox Hills Sandstone yields moderate quantities of good quality water to properly constructed wells in eastern Meade and northern Butte Counties, and along the southwestern flank of the Black Hills in Niobrara County in Wyoming.

Alluvium is an important source of water for stock and domestic use. It is a mixture of gravel, clay, sand, and boulders in varying proportions, and is present in the valleys of most Black Hills streams.

In some areas, wells in alluvium produce water that is adequate for small-scale irrigation or industrial use.

Quality of the Water

The quality of water depends chiefly on concentrations of dissolved solids and various substances held or transported as sediment by the water. Amounts of both dissolved solids and sediment differ with location, especially in an area as diverse in topography, geology, and hydrology as the Black Hills. In surface water, concentrations are highly responsive to changes in water discharge, and are changing continually at any given streamsite. Concentrations of dissolved solids in ground water also may change, but generally only by small amounts.

The estimated "modal" concentration—that concentration one might expect to occur most often—of dissolved solids for streams in the Black Hills area (map 7) nearly doubles in the Belle Fourche River between Moorcroft, Wyoming, and Elm Springs, South Dakota. This is due to the highly mineralized return flow from irrigation and to contributions from plains tributaries draining shales.

Modal concentrations of dissolved solids are generally less below large storage reservoirs, such as the Keyhole and Angostura, than upstream, because of mixing in the reservoirs themselves.

Water from nearly all streams in the area is very hard, ranging from about 200 ppm as calcium carbonate for small streams draining the high elevations to 500 ppm and frequently 1,000 ppm in the Cheyenne and Belle Fourche Rivers. In the majority of the streams, most of the hardness is of the noncarbonate type.

In the headwater regions of the Belle Fourche and Cheyenne Rivers, sodium is more abundant than in the rest of the area, and water is likely to be of the sodium sulfate type during periods of low flow. Water from most creeks draining the high elevations of the Black Hills is of the calcium bicarbonate type characteristic of water from mountain areas. It contains relatively low concentrations of dissolved solids.

Water from the Belle Fourche and Cheyenne Rivers and from many tributaries of these streams has been used satisfactorily for irrigation for many years. Although the water is highly saline much of the time, the capacities of Keyhole, Belle Fourche, and Angostura Reservoirs allow storage of high, spring flows that are relatively dilute, and mixing in the reservoirs improves water quality below them. The salinity of "run of the river" water during periods of low streamflow is often high enough that direct diversion from these rivers could cause salts to accumulate in the soils if the water were used to irrigate lands with inadequate subsurface drainage.

Water from most small streams is satisfactory for stock watering and, if softened, probably would be satisfactory for municipal use. The extreme hardness and high concentrations of sulfate in water from the Belle Fourche and Cheyenne Rivers, however, make them undesirable as sources of municipal supply without treatment.

The central Black Hills area is composed of granite and metamorphic rock that is resistant to erosion. The soil mantle is thin in many places and covered by relatively dense vegetation. Consequently, although slopes are steep and runoff rapid, erosion and sediment deposited in streams are relatively minor.

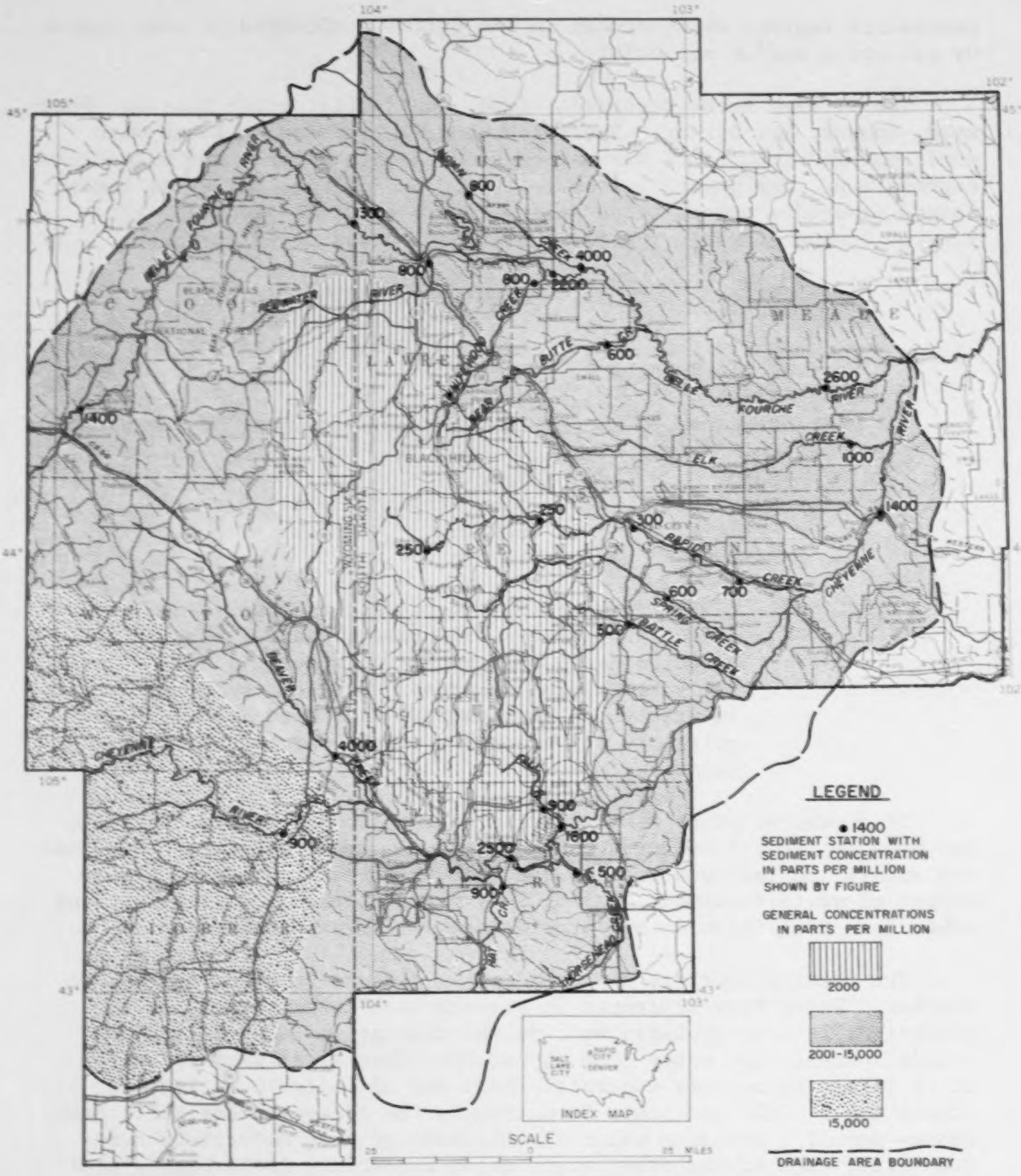
Most sediment is transported by torrential flows during spring or summer thunderstorms which provide most of the annual precipitation. It originates from three major erosion processes—sheet, gully, and channel-bank erosion. Severe sheet erosion throughout the upper Cheyenne River basin is the principal source of sediment deposited in Angostura Reservoir. Sheet erosion is also probably the principal source of sediment transported by streams in the Wyoming Belle Fourche River basin.

Sediment transport characteristics of streams are highly variable (map 7). At a Belle Fourche River sampling station near Moorcroft, Wyoming, a 1-1/2-year study showed an average production of about 8.5 tons of sediment per acre-foot of runoff. Sediment concentrations in the Belle Fourche River downstream from the Belle Fourche Reservoir generally exceed those upstream. Mill tailings contributed by Whitewood Creek constitute a high proportion of the suspended sediment and bed material in the lower Belle Fourche River.

A 4-year study of Lance Creek (a major tributary to the Cheyenne River) near Spencer, Wyoming, showed an average production of about 40 tons of sediment per acre-foot of runoff. A 7-year study at the gaging station on Beaver Creek (also a Cheyenne River tributary) 23 miles south of Newcastle, Wyoming, showed a production of about 1 million tons over the 7-year period, or about 8 percent of the total sediment production above Angostura Reservoir. Since 1949, Angostura Reservoir has trapped over 99 percent of the inflow sediment—this has amounted to an average of about 1.6 million tons per year.

The composition of sediment in most streams in the Black Hills area is 60 to 80 percent clay, 10 to 30 percent silt, and less than 10 percent sand. Because of mill tailings, the reverse is true of Whitewood Creek and downstream in the Belle Fourche River.

In addition to sediment, other pollutants affect water quality on many streams and some reservoirs. Nearly 240 miles of stream in the nine-county area suffer from severe pollution or siltation (table 26). Domestic wastes and industrial wastes, including mine and mill wastes, severely limit water quality for many important functions on some of the Hills' most important streams. With the exception of those in the



MAP 7. ESTIMATED MODAL CONCENTRATIONS OF DISSOLVED SOLIDS AND SUSPENDED SEDIMENT CONCENTRATIONS

headwaters region, every stream in the Hills is affected to some degree by pollution and/or siltation.

The streams below Newcastle, Lead, Rapid City, Belle Fourche, Deadwood, Custer, Hot Springs, Spearfish, and Sturgis are polluted with municipal and industrial wastes, creating health hazards and watercourse degradation. The physical, chemical, and biological quality of these waters precludes use of these streams for beneficial purposes. The present status of waste treatment at these places is as follows:

City	Treatment plants*
Rapid City	Secondary (under construction)
Belle Fourche	Lagoon
Custer	Secondary
Deadwood	None (primary for part of the waste)
Hot Springs	Secondary
Lead	None
Spearfish	Secondary
Sturgis	Lagoon
Newcastle	Lagoon

* Lagoon and secondary treatment are considered adequate. However, the treated wastes should be chlorinated when receiving stream is used for recreational purposes. Nutrient reduction in discharged effluents is also needed where nutrients may adversely affect downstream water uses.

It should be pointed out that although secondary waste treatment has been considered adequate in the past, the great recreation use that now exists and the much greater use that is forecast demand a higher degree of waste treatment. Also, many private homes, campgrounds, and other such facilities do not provide adequate sewage treatment.

The chemical quality of ground water differs from one aquifer to another. Water from fractures in Precambrian basement rocks in the central Hills area probably has, on the average, a lower dissolved-solids content than water from any of the other stratigraphic units. It is likely to be only moderately hard and of suitable quality for all common uses. Only one other formation in the area—the Fox Hills Sandstone—normally contains water that is soft or only moderately hard. Generally, each of the other eight major formations yield highly mineralized water.

The chemical quality of water from alluvium is highly diverse and seems to be closely related to the type of water in the underlying bedrock. Water from alluvium in the central Hills area is low in dissolved-solids content in many places and is, therefore, used for municipal supply where adequate quantities can be obtained.

Uses of Water

The largest single use of water in the Black Hills area is for irrigation. As shown in a previous section of this report, 103,000 acres of land is irrigated. About 65 percent of this total is irrigated from reservoir storage; another 7 percent receives a supplemental supply from storage; and 28 percent is from natural streamflows. It is estimated that irrigation reduces the Cheyenne River streamflow an average of 165,000 acre-feet annually. About 6,000 acre-feet of ground water per year is used for irrigation. Nearly 930 acre-feet annually is used for domestic farm supply and about 5,240 acre-feet for livestock. Approximately 10.6 million gallons per day, or 11,900 acre-feet per year, was used for municipal supply in the area in 1965. Ground-water sources supplied about 58 percent and surface-water sources the rest. Self-supplied water for industrial purposes was about 19,000 acre-feet per year in 1965, of which about 41 percent was ground water and the rest, surface water.

Some form of recreation use is made of almost all surface water. Water, be it stream, river, pond, lake, reservoir, or canal, is a powerful attraction to the recreationist. Approximately 700 miles of streams and 51,500 surface acres of water in lakes and impoundments are available for recreation in the Black Hills area. People find special enjoyment in looking at, resting by, or camping near streams. The total length and surface area of perennial streams is less than might be expected in this area of high relief and moderate rainfall. Only 29 percent of the total stream length is classified as "adequate" for trout. Most of the better trout streams are within the boundaries of the Black Hills National Forest.

Legal Status

In South Dakota and Wyoming, water is declared to be the property of, and is administered by, the State government. Before water can be developed, a "water right" must be obtained from the appropriate State agency. In considering resource development on Federal lands, the United States will need to determine the applicability of the rules announced in Arizona v. California, 373 U.S., 546,601.

Water rights on all streams in the Cheyenne River basin in Wyoming have been adjudicated by the State with priorities dating as early as 1877. The right to divert natural flows for beneficial use follows a basic principle of Wyoming law allowing one cubic foot per second for each 70 acres. In 1945, the Wyoming law was amended, granting floodwater rights to holders of adjudicated water rights and valid permits or filings with a priority date before March 1, 1945. This allowed an additional diversion of one cubic foot per second for each 70 acres covered by an original water right when available during periods of high runoff and thus placed a restriction on storage of such runoff under new developments.

Wyoming water laws recognize preferred uses of water. Existing rights not preferred may be condemned to supply water in the following order of preference:

1. Water for drinking purposes for both man and beast. (This is construed as domestic household use and stock-water use.)
2. Water for municipal purposes.
3. Water for steam engines and general railway use, water for culinary, laundry, bathing, refrigerating (including the manufacture of ice), for steam and hot water heating plants, and steam powerplants.
4. Water for industrial purposes.

The preferred use of water for steam powerplants and industrial purposes does not carry the right of condemnation. The use of water for irrigation is superior and preferred to any use where water turbines or impulse water wheels are installed for power purposes.

In 1957, a new Underground Water Law was passed by the Wyoming Legislature. It declared water rights acquired before April 1, 1947, as vested rights. It further provided that after March 1, 1958, anyone intending to acquire a right to use of underground water for other than domestic or stock use must secure a permit from the State Engineer.

Surface and underground waters of the State of South Dakota are administered by the State Water Resources Commission which was established when a new water law was enacted by the 1955 State Legislature. This new law establishes the doctrine of appropriation, but it recognizes both riparian and appropriative rights that were in use or valid at the time the new law was enacted.

It is the established policy of the State that: (1) the use of water for domestic purposes is the highest use of water and takes precedence over all appropriative rights; and (2) the right of a municipality to acquire and hold rights to the use of water should be protected to the fullest extent necessary for existing and future uses.

Water rights for use of surface waters in the Cheyenne River basin in South Dakota which are primarily for irrigation have priorities dating as early as 1876. The amount of water allowed for irrigation is one cubic foot per second for each 70 acres, and the volume of water diverted for use cannot exceed three acre-feet per acre each year, delivered on the land for a specified time each year. The rate of one cubic foot per 70 acres does not apply in cases when the flow of a stream is in excess of the total water rights on the stream.

In general, streams in the Black Hills area in both South Dakota and Wyoming are overappropriated during the summer months when demands for water are greatest and when natural streamflows are low. Any further development of surface waters will probably require provision of storage for control of spring runoff and winter flows.

The Belle Fourche River Compact was ratified by the State Legislature of Wyoming and South Dakota and confirmed by the Congress of the United States in 1944 (58 Stat. 94). It provides that:

1. Unappropriated waters of the river as of date of compact shall be allocated 90 percent to South Dakota and 10 percent to Wyoming; provided that allocations to Wyoming shall be exclusive of domestic and stock-water uses, and that such uses in Wyoming shall be unrestricted except that no reservoir for such use shall exceed 20 acre-feet in capacity. "For storage of its allocated water, Wyoming shall have the privilege of purchasing at cost not to exceed 10 percent of the total storage capacity of any reservoir or reservoirs constructed in Wyoming for irrigation of lands in South Dakota, or may construct reservoirs itself for the purpose of utilizing such water."

2. Appropriative rights to beneficial use in each State as of date of compact, for direct diversion or storage, are recognized and shall continue to be enjoyed to the extent these rights are valid under the law of the State in which use is made and shall remain unimpaired.

3. Waters allocated under 1 and rights recognized under 2 are referred to collectively as the "apportioned" water.

   "For the purpose of the administration of this compact and determining the apportioned water at any given date within a given calendar year, there shall be taken the sum of:

   "(a) The quantity of water in acre-feet that passed the Wyoming-South Dakota state line during the period from January 1 of that year to that given date.

   "(b) The quantity of water in acre-feet in storage on that date in all reservoirs built in Wyoming on the Belle Fourche River subsequent to the date of the compact."

4. Any reservoir constructed in Wyoming, used principally for irrigation of lands in South Dakota, shall release sufficient water at all times for stock-water use, not to exceed 10 cubic feet per second.

5. No reservoir hereafter built solely to utilize the water allocated to Wyoming shall have a capacity in excess of 1,000 acre-feet.

A Cheyenne River Compact draft was ratified by the Wyoming and South Dakota Legislatures in 1949 but failed to receive the consent of the Congress. In 1955, the second version was ratified by the South Dakota Legislature but not the Wyoming Legislature.

AGRICULTURE

Production

The estimated sales of agricultural products from farms in the Black Hills area in 1959 was more than $50 million. About 88 percent was from the sale of livestock and livestock products.

In South Dakota, approximately 86 percent of the value of total livestock and livestock products marketed is from livestock sales of cattle and sheep. These sales include calves and lambs. Cattle and calves represent about 69 percent of the sales, while sheep and lambs account for 17 percent. A similar comparison in Wyoming shows 94 percent of the total value of livestock and livestock products sold is from the cattle and sheep. Cattle and calves make up 81 percent of the sales, while sheep and lambs account for 13 percent. Table 16 shows number marketed in 1959.

Table 16.—Numbers of livestock sold in 1959

Type	South Dakota	Wyoming	Total
Cattle and calves	149,645	80,258	229,903
Horses and mules	574	371	945
Hogs and pigs	17,410	1,298	18,708
Sheep and lambs	388,827	147,238	536,065

The Black Hills area produces agricultural products other than livestock valued in excess of $15 million per year. About $6 million worth is marketed and the rest is consumed as livestock feed.

Table 17 lists the principal crops grown and the production of each crop in 1959. Other crops grown in small amounts are rye, flax, emmer, spelt, millet, safflower, crested wheat, vegetables, and berries.

Table 17—Principal crops in 1959

Crop	Unit	South Dakota	Wyoming	Total
Corn - grain	Bu.	417,886	3,636	421,522
Corn - silage	Ton	50,972	11,090	62,062
Corn - grazed or fodder	Ac.	21,864	3,846	25,710
Sorghum - grain	Bu.	11,305	-	11,305
Sorghum - silage	Ton	664	220	884
Sorghum - grazed or fodder	Ac.	7,942	282	8,224
Winter wheat	Bu.	1,113,223	446,223	1,559,446
Spring wheat	Bu.	357,450	98,861	456,311
Oats	Bu.	445,476	199,679	645,155
Barley	Bu.	201,353	97,813	299,166
Alfalfa hay	Ton	232,865	50,289	283,154
Clover	Ton	8,528	1,745	10,273
Small grain - hay	Ton	13,216	12,281	25,497
Wild hay	Ton	32,730	8,367	41,097
Alfalfa seed	Lb.	1,142,631	112,790	1,255,421
Potatoes	Bu.	23,597	3,120	26,717
Sugar beets	Ton	87,971	-	87,971

On irrigated land, corn, alfalfa hay, vegetables, and sugar beets have been the principal crops. Since the sugar refinery at Belle Fourche closed in 1965, the beet acreage has been used to produce additional corn, alfalfa hay, and dry beans. About 80 percent of the grain, corn, and vegetables, and more than 30 percent of the alfalfa hay are produced on irrigated land.

The production of grass (for either pasture or hay) is difficult to evaluate in terms of pounds or tons. Most of it is utilized in the production of domestic livestock. A large amount, however, is utilized by big game and other forms of wildlife.

In 1959, the area supported more than a million cattle and sheep. An essential part of the forage required to support this livestock population is provided through lease and permit arrangements with ranchers by several Federal and State agencies. Grazing is permitted on Federal land for an average of about five months during the warm season for more than 150,000 cattle and 200,000 sheep. More than 800,000 acres of State School lands leased to ranchers provide additional grazing and support of the livestock industry.

Conservation of Soil, Water, and Plant Resources

Well over half of the 4,149 farm and ranch units (1965) in the area have signed cooperative agreements with their local soil and water conservation districts. Plans have been completed and a high percentage of needed conservation practices have been applied to 1,810 of the units. Standard soil survey mapping has been completed on 1,575,000 acres and soil conservation soil surveys on 3,530,000 acres.

Conservation plans may provide for both vegetative and structural measures. Table 18 shows the principal types and amounts of conservation measures that have been applied in the area.

Federal financial assistance (cost-sharing) to establish most of the farm and ranch conservation practices has been provided through the Agricultural Conservation Program (ACP) administered by the Agricultural Stabilization and Conservation Service, and the Great Plains Conservation Program administered by the Soil Conservation Service. Technical assistance for these conservation measures was provided by the Soil Conservation Service and the Forest Service. Participation in the Agricultural Conservation Program has been high. During the period 1960-64, 3,528 farms and ranches participated at least one year.

Many soil and water conservation projects have been completed or are underway on Federal lands in the area. Thousands of acres of depleted or burned-over lands have been revegetated with trees and grass. Range weeds have been controlled, fences have been constructed, and numerous water developments built for game and livestock. Contour furrows, debris basins, and artificial catchment basins for water storage have been installed on a limited basis. Experimental water yield improvement studies and watershed analysis projects have been initiated to develop appropriate land treatment plans for erosion control and flood hazard reduction.

The Great Plains Conservation Program is designed to assist farmers and ranchers in developing and carrying out, on a voluntary basis, a plan of conservation operations. Such plans will bring about greater stability through cropping and grazing systems and land-use changes along with the application of enduring soil and water conservation practices. The program was devised to help minimize the hazards of farming and ranching caused by the erratic climate of the area.

In this study area, one county in South Dakota and one in Wyoming have only been participating in the program a short period. In addition, one Wyoming county is not now participating. Even so, by the end of 1965, Great Plains Conservation Program contracts had been developed on 157 farms and ranches covering 746,560 acres.

The Conservation Reserve (or Soil Bank) Program has been and still is important to the area. As contracts expire each year (table 19), about one-third of the acreage remains as hay or pasture land.

The Cropland Adjustment Program is designed to shift wheat and feed grain acreages to conserving uses (with adjustment payments to landowners extending for periods of five to ten years). These lands are diverted to perennial grass cover, tree cover, wildlife vegetative cover, or ponds. Under certain conditions, the public may make use of

Table 18.—Principal conservation treatment on farms and ranches (1965)

PASTURE AND RANGE

State	Grass seeding[a]/ (acres)	Deferred grazing (acres)	Proper range use (acres)	Water[b]/ developments (number)	Water spreading (acres)	Diversions (miles)	Fish pond treatment (number)
South Dakota	83,433	1,025,699	2,691,614	12,433	53,712	188	1,341
Wyoming	18,962	46,804	609,661	3,656	28,390	332	44
Total	102,395	1,072,503	3,301,275	16,089	82,102	520	1,385

CROPLAND (IRRIGATED)

State	Proper irr. water use (acres)	Land leveling (acres)	Irr. field ditches (miles)	Ditch & canal lining (miles)	Irrigation[c]/ reservoirs (number)	Sprinkler irrigation systems (No.)	Mains & laterals (miles)
South Dakota	44,364	35,220	969	387	149	31	--
Wyoming	2,098	1,010	9	2	68	15	11
Total	46,462	36,230	978	389	217	46	11

CROPLAND (DRYLAND)

State	Terraces (miles)	Contouring (acres)	Wind strip cropping (acres)	Waterways (acres)	Stubble mulching (acres)	Grade stab. structures (each)	Wildlife hab. pres. (acres)
South Dakota	493	34,226	95,939	574	146,994	29	10,816
Wyoming	425	15,864	39	196	600	235	15
Total	918	50,090	95,978	770	147,594	264	10,831

[a]/ Includes pasture and hay planting and range seeding.
[b]/ Includes farm ponds, springs, and wells.
[c]/ For individual operators.

these areas for hiking, hunting, fishing, and other outdoor recreational pursuits.

Table 19.—Conservation reserve program

State	No. of contracts			Acres		
	1960	1966	1969	1960	1966	1969
Wyoming	82	31	4	16,236	8,075	626
South Dakota	177	62	21	41,745	20,710	8,910

Credit

To supplement services of local banks, insurance companies, and other lending institutions, the Farmers Home Administration (FHA) serves individual farmers and ranchers with credit and technical help to improve farms and homes, increase income, and develop farm or ranch resources. In the past five years, more than 2,500 loans have been made to applicants unable to obtain adequate credit from other sources at reasonable rates and terms.

Loans are also available to nonprofit rural associations of public groups, to establish, develop, or improve grazing, forestry, recreation, sewer, water, or watersheds for their mutual benefit.

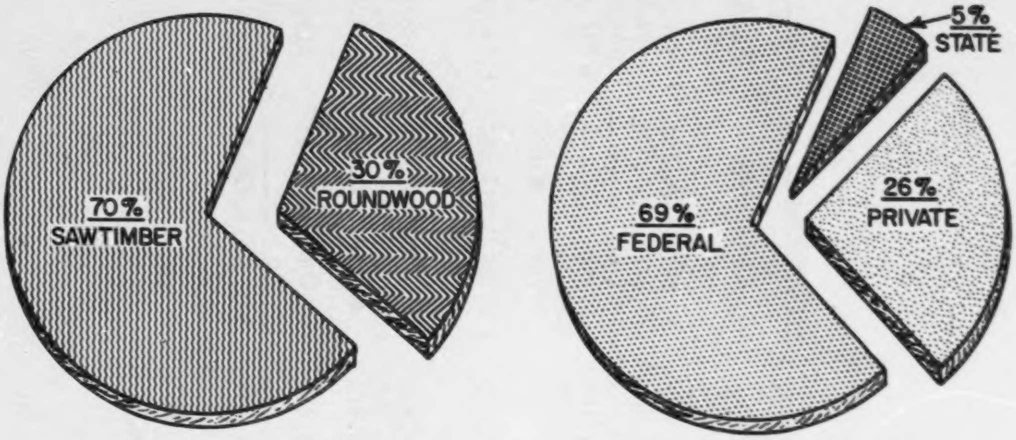
Association loans are also available under the Economic Opportunity Act through FHA to small informal groups and to formally organized cooperatives for the development of a service or purchase of equipment which would serve the mutual interests of their members.

TIMBER

The Volume of Timber

The volume of commercial timber in the Black Hills is estimated to be about 5 billion board feet (Int. 1/4" rule). Sawtimber stands (these are trees more than 9 inches dbh—the diameter breast high measured 4-1/2 feet above the ground) contain about 3.5 billion board feet, and roundwood stands (trees used to make posts, poles, or pulpwood) make up the remaining portion or about 426 million cubic feet. Graph 10 shows the percent distribution of roundwood and sawtimber on public and private lands. Table 20 lists timber volumes by State and county in public and private ownership.

GRAPH 10. PERCENT OF TIMBER VOLUME



SAWTIMBER AND ROUNDWOOD

BY LAND OWNERSHIP

Over 90 percent of the timber volume comes from ponderosa pine. The largest tree discovered in the area to date is 135 feet tall and 42 inches dbh. The wood from the ponderosa pine, entirely suitable for most residential and commercial building purposes, is one of the most popular multipurpose softwoods in current use in the United States.

Although white spruce, commonly called "Black Hills spruce", provides less than 10 percent of the total volume, it ranks second to pine in economic importance in the area. It is used primarily for pulpwood and Christmas trees, and makes very attractive paneling.

The Rocky Mountain juniper and Plains cottonwood are also used. The Rocky Mountain juniper is highly resistant to decay and therefore is widely used for fence posts and poles. It also is used for fuel, lumber, and cedar chests. The Plains cottonwood is a short-lived, rapidly growing tree that produces lumber that is better suited for certain building purposes than most other woods. It is a wood of many uses, including pulp for high-grade gloss paper. Cottonwood was held in great esteem by the early settlers. Throughout the Great Plains, it provided them with building material, shelter, and fuel.

Timberland, as used in this report, includes commercial and noncommercial forest lands. Areas at least 10 percent occupied by growing trees containing a net volume per acre of 1,500 board feet (Int. 1/4" rule) or more in sawtimber-sized trees are considered commercial. Stands that do not meet this specification or are withdrawn from cutting

Table 20.—Commercial timber volume by State, county and owner

	Forest Service		Bureau of Land Management		State		Private		Total	
	M a/ cu. ft.	b/ MBM	M cu. ft.	MBM	M cu. ft.	MBM	M cu. ft.	MBM	M cu. ft.	MBM
SOUTH DAKOTA										
Pennington	308,792	1,091,937	661	2,471	127	481	21,882	74,161	331,462	1,169,050
Meade	28,072	99,267	1,049	3,881	516	1,927	10,003	33,901	39,640	138,976
Lawrence	212,960	753,060	11,236	41,573	902	3,373	36,175	122,602	264,273	920,608
Custer	247,808	876,288	0	0	40,990	153,228	18,473	62,610	307,271	1,092,126
Fall River	33,880	119,805	0	0	430	1,606	24,406	82,716	58,716	204,127
Butte	0	0	0	0	0	0	788	2,672	788	2,672
Subtotal	831,512	2,940,357	12,946	47,925	42,965	160,615	111,727	378,662	1,002,150	3,527,559
WYOMING										
Crook	131,648	465,528	6,610	24,710	12,540	46,877	167,491	567,656	318,289	1,104,771
Weston	4,840	17,115	5,949	22,239	9,366	35,012	71,478	242,251	91,633	316,617
Niobrara	0	0	0	0	5,063	18,928	14,599	49,478	19,662	68,406
Subtotal	136,488	482,643	12,559	46,949	26,969	100,817	253,568	859,385	429,584	1,489,794
TOTAL	968,000	3,423,000	25,505	94,874	69,934	261,432	365,295	1,238,047	1,431,734	5,017,353

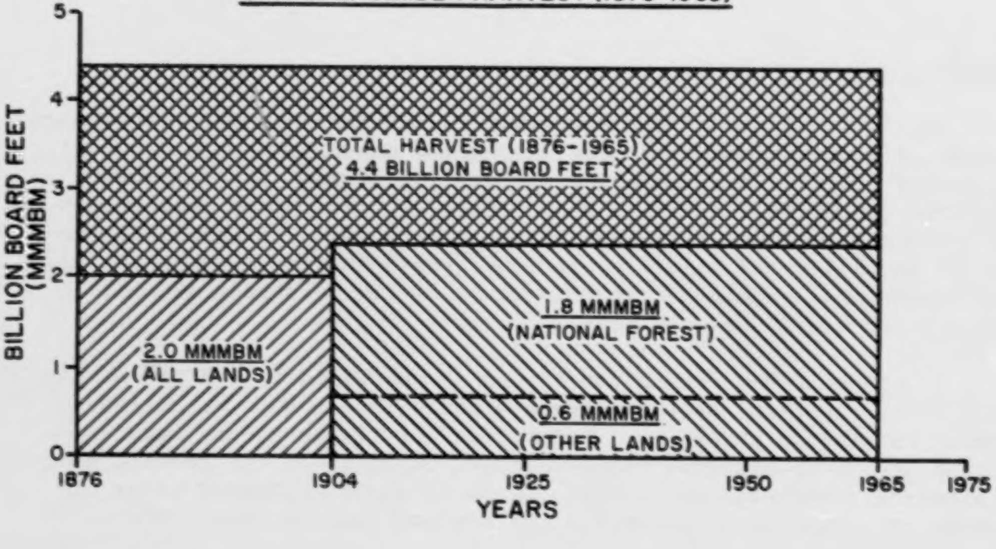
a/ M cu. ft. is one thousand cubic feet.
b/ MBM is one thousand board feet by International 1/4" rule.

through statute or administrative regulation are classified as noncommercial. There are about 2.122 million acres of timberland in the area. About 89 percent, or 1.877 million acres, is commercial. Slightly more than 59 percent of the commercial timberland, 1.115 million acres, is in the Black Hills National Forest. Private landholders own 618,000 acres, and other public agencies hold the balance of 144,000 acres. About 65 percent of the commercial forest land is in South Dakota and 35 percent is in Wyoming. Acreages used here represent lands with trees predominating. Lands may also be classified in accordance with primary current use. (See previous discussion of "LAND.")

Timber Harvest

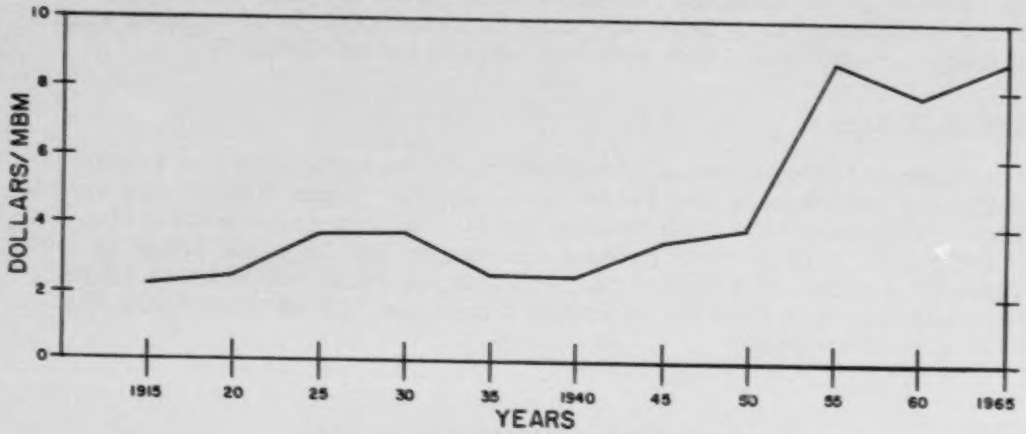
Commercial production of various wood products from the Black Hills has been almost continuous since logging began intensively around 1876. The total estimated harvest until 1965 was about 4.4 billion board feet. More than 45 percent was cut in the 26 years prior to creation of the national forest in 1903. Since 1903, 1.8 billion board feet has been cut from the national forest and 600 million board feet from all other lands.

GRAPH II. TIMBER HARVEST (1876-1965)



For the first four decades of the 20th century, selling prices and volumes of trees cut from the Hills remained fairly constant; the demands of World War II, however, brought a sharp rise. Since then, average selling prices for Black Hills ponderosa pine lumber have varied generally from $70 to $90 per thousand board feet (MBM)—compared to an average of $21 per MBM before the war. Stumpage prices also have more than tripled (stumpage price is the value of wood in the standing tree prior to cutting).

GRAPH 12. BLACK HILLS AREA STUMPAGE PRICE (1915-1965)



Forest Regulation

The "allowable cut" for sawtimber is an expression of the maximum volume of mature timber that can be removed annually for an extended period of time without depleting the growing stock. The "allowable cut" for roundwood, in a regulated forest, is the volume that should be thinned from immature stands of trees each year, to forestall premature mortality and maintain vigorous growth in the trees remaining. The combined allowable cut in both kinds of timber stands exceeds 220 million board feet per year.

At present, the demand for timber in the Hills is equivalent to only about one-third of the allowable cut. Throughout the history of timber cutting in the Hills, "actual cut" of timber in any extended period has never exceeded the productive capacity of the growing stock (including roundwood) available. Graph 13 shows estimated rates of actual cut compared to allowable cut for each decade since 1924.

The estimated annual growth in the sawtimber and roundwood stands in the Hills exceeds 100 million board feet and 11.9 million cubic feet, respectively.

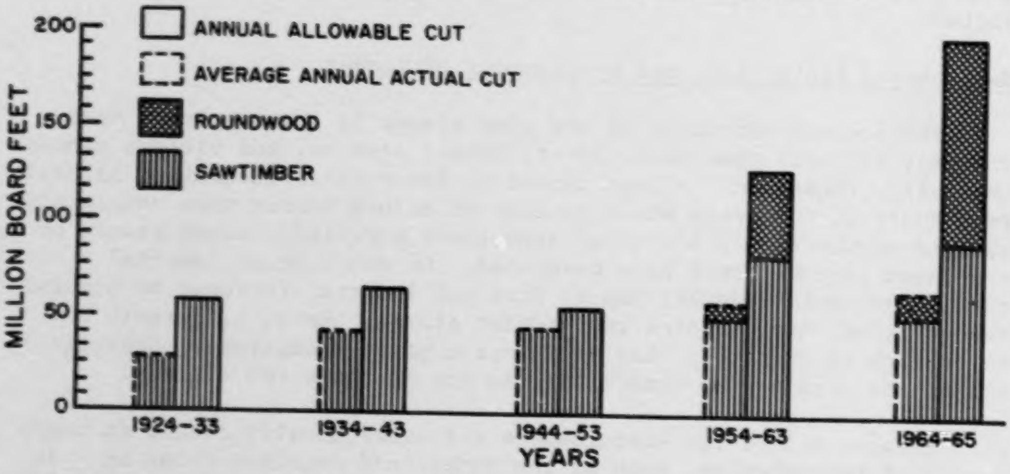
The present estimated inventory of 5 billion board feet of standing timber can be increased substantially through intensive management to about 7 billion board feet.

Table 21.—Estimated allowable cut

		Allowable cut		
	Commercial timberland	Roundwood	Sawtimber	
Ownership	Total acres	M-cords a/	Int. 1/4" MMBM b/	Scrib.Dec.C. MMBM
South Dakota				
National forest	957,699	139.5	65	55
Other public	84,362	8.3	5	4
Private	189,047	18.3	6	5
Subtotal	1,231,108	166.1	76	64
Wyoming				
National forest	157,201	30.0	14	12
Other public	59,800	8.5	4	3
Private	429,049	55.5	23	19
Subtotal	646,050	94.0	41	34
Total	1,977,158	260.1	117	98

a/ M-cords = Thousand cords.
b/ MMBM = Million board feet.

GRAPH 13. ESTIMATED ACTUAL CUT VS. ALLOWABLE CUT



Local Processing and Consumption of Black Hills Ponderosa Pine

Based on the average per capita consumption index (The Demand and Price Situation for Forest Products, USDA - Miscellaneous Publication No. 983), local use of Black Hills timber is about 41 percent of the total production. The Homestake Mining Company uses about one-third of this volume in its mining operations.

Nearly all of the sawtimber cut in the Hills is processed locally. The pulpwood, in the form of rough cords, is shipped to Wisconsin mills for processing and becomes an unidentifiable portion of the Nation's entire consumption of pulp and paper products.

Lumberyards that are not associated with local sawmills sell about 90 percent imported lumber and other wood products, such as plywood, particle board, and dimension stock, and only 10 percent Black Hills lumber. The reverse is true for local retail lumberyards that are associated with local sawmills.

About 19 percent (or 225,000 cubic feet) of the annual post and pole production is consumed locally. Almost all of the output of the smaller post and pole wood preserving companies is used locally. The larger companies, however, export about 90 percent of their production. The volume of imported materials is less than one-half of one percent of the total. However, posts and poles produced in the southern United States and other parts of the country have found markets within 200 miles of the Black Hills.

The average per capita consumption index for pulp and paper products is about one-fifth of a cord per year. It requires 25,000 cords of pulpwood to produce the pulp and paper products consumed by the people of the Black Hills each year. At present, all of this is imported.

Management, Protection, and Development of Timber

The present character of the pine stands is the result of past logging, cultural practices, fires, insect attacks, and violent storms. Generally, these factors have tended to favor establishment of natural reproduction. On areas where patches of mature timber were completely removed or where only scattered seed trees were left, dense stands of even-aged second-growth have developed. On other areas, partial cutting and selective killing by fire and insects, followed by natural regeneration, have created two-storied stands. Here, old growth remnants form an overstory that dominates a young understory. Essentially all of the area's pine stands fall in one of these two classes.

Because all of the disturbances discussed usually result in heavy stands of reproduction, much of the timberland requires thinning. In the 1930's, the Civilian Conservation Corps thinned more than 250,000 acres of these dense stands. Since being released, this timber has grown considerably in size; today, it is being harvested for posts, poles, and pulpwood. Less than 13,000 acres of these dense stands are currently being thinned per year.

Tree planting is largely confined to burned areas where the natural seed source has been destroyed. Following destructive fires, shrub and hardwood tree vegetation usually dominate areas on which commercially valuable ponderosa pine was killed. Several destructive fires in the 1930's denuded extensive areas. Return of these areas, by natural means, to commercial wood production is often exceedingly slow, and today large acreages remain covered with grass, hardwood shrubs, and aspen. The current rate of tree planting in the Hills is about 1,000 acres per year. Roughly two-thirds of the old burns have been reforested.

After the first few years on many such ponderosa pine plantations, rapidly growing noncommercial hardwood species overtop the young pine trees and suppress their growth. A continuing release program on the better conifer sites, which removes the overtopping hardwoods, helps maintain vigorous, healthy conditions in the ponderosa pine stands.

About half of the plantations are fenced to protect them from the damaging effects of grazing animals, and about 20 percent receive control measures for protection from excessive damage by various rodents.

Historically, the Black Hills bark beetle has been the most damaging insect to trees in the area. Local populations of this insect have been reduced to endemic levels through aggressive cooperative control programs of local, private, State, and Federal agencies. A continuous training program in the recognition and detection of this beetle is maintained so that prompt control action can be taken should damaging population concentrations develop.

Managemenc programs for timber in national parks, monuments, and memorials in the Black Hills have been limited to occasional tree planting on man-made scars from construction and to control of devastating insect and disease epidemics. Such programs follow the National Park Service policy of preserving lands in their natural condition.

MINERALS

Mineral production from the days of the first records in 1879 to the present has grown consistently, responding favorably to each period of increased demand. In South Dakota, during this period, gold accounted for 66 percent of the total value of the mineral production; the nonmetallic commodities of sand, gravel, stone, cement, and clay accounted for an additional 30 percent. The remaining 4 percent came

Table 22.—Mineral resources

Map No.	District, area, or mine
	GOLD AND SILVER
1	Lead
2	Deadwood-Two Bit
3	Garden
4	Bald Mountain
5	Squaw Creek
6	Ragged Top
7	Cloverleaf
8	Keystone
9	Hill City
10	Rochford
11	Ivanhoe
	URANIUM
12	Carlile
13	Barlow Canyon
14	Hulett Creek
15	Elkhorn Creek
16	Aladdin
17	Southern District (includes 34 mines as well as several dozen not plotted)
	IRON
18	Rochford-Nahant
19	Two Bit Gulch
20	Iron Mountain
21	Strawberry Ridge
22	Hayward
23	Bobcat Gulch
24	Nemo
25	Siderite-hematite-limonite deposits
	LEAD AND ZINC (includes some silver)
26	Carbonate
27	Galena
28	Spokane
29	Silver City
30	Calabogia
31	Spruce Gulch
	MOLYBDENUM
32	Indian Creek
33	Runge
	CLAYS, BENTONITE, & LIGHTWEIGHT AGGREGATE
34	Clay and shale pits used for brick
35	Clay and shale pit used for lightweight aggregate and cement
	PEGMATITE
36	Area containing feldspar, lithium, mica, beryl, tantalite-columbite, and tin in pegmatites. Major mines are signified by °.
	GYPSUM
37	Sundance
38	Spearfish
39	Sturgis
40	Piedmont
41	Black Hawk
42	Rapid City
43	Hot Springs
44	Erskine

from a wide variety of minerals. Map 8 shows the general location of most major mineral resources in the area.

Local communities of Lead and Deadwood in the northern mountains depend heavily upon mining. The Homestake Mining Company in that area blocks ore reserves for at least 10 years in the future. A few towns in the southern mountains, such as Custer and Keystone, are still at least partially dependent upon mining income from small mines operated by individuals or families.

Mineral Commodities of Importance

Petroleum production, as can be seen in table 23, has been the most valuable of all mineral commodities in the nine-county Black Hills area in recent years. It has been a strong but irregular factor in the economy. Periods of boom have followed discoveries of new fields and introduction of secondary recovery methods in old fields. Recent major discoveries have been in the Newcastle, Fall River, Lakota, and Minnelusa Sandstones (western Crook County currently is experiencing a boom from discoveries in the latter). The Lance Creek field, however, has been the principal sustained producer since 1918.

Gold has been second in production value; it reached a new high of 617,000 ounces in 1964. The most productive mines have been in the Precambrian rocks or overlying sediments in Lawrence County. Homestake Mining Company at Lead (photo 1) has been the largest operation since World War I and the only sustained producer since the Bald Mountain mines were shut down in July 1959.

The third most valuable production in 1964 was bentonite. Black Hills bentonite is derived primarily from the 3- to 4-feet-thick Clay Spur bed. Pioneer processing plants were established about 1927 in Weston County, Wyoming. Because most of the clay is used as a binder for foundry sands, and as a mud additive in oil well drilling, production has fluctuated with the activity of those particular industries. Recently, use of bentonite as a binder in pelletizing taconite has added a third large, expanding outlet.

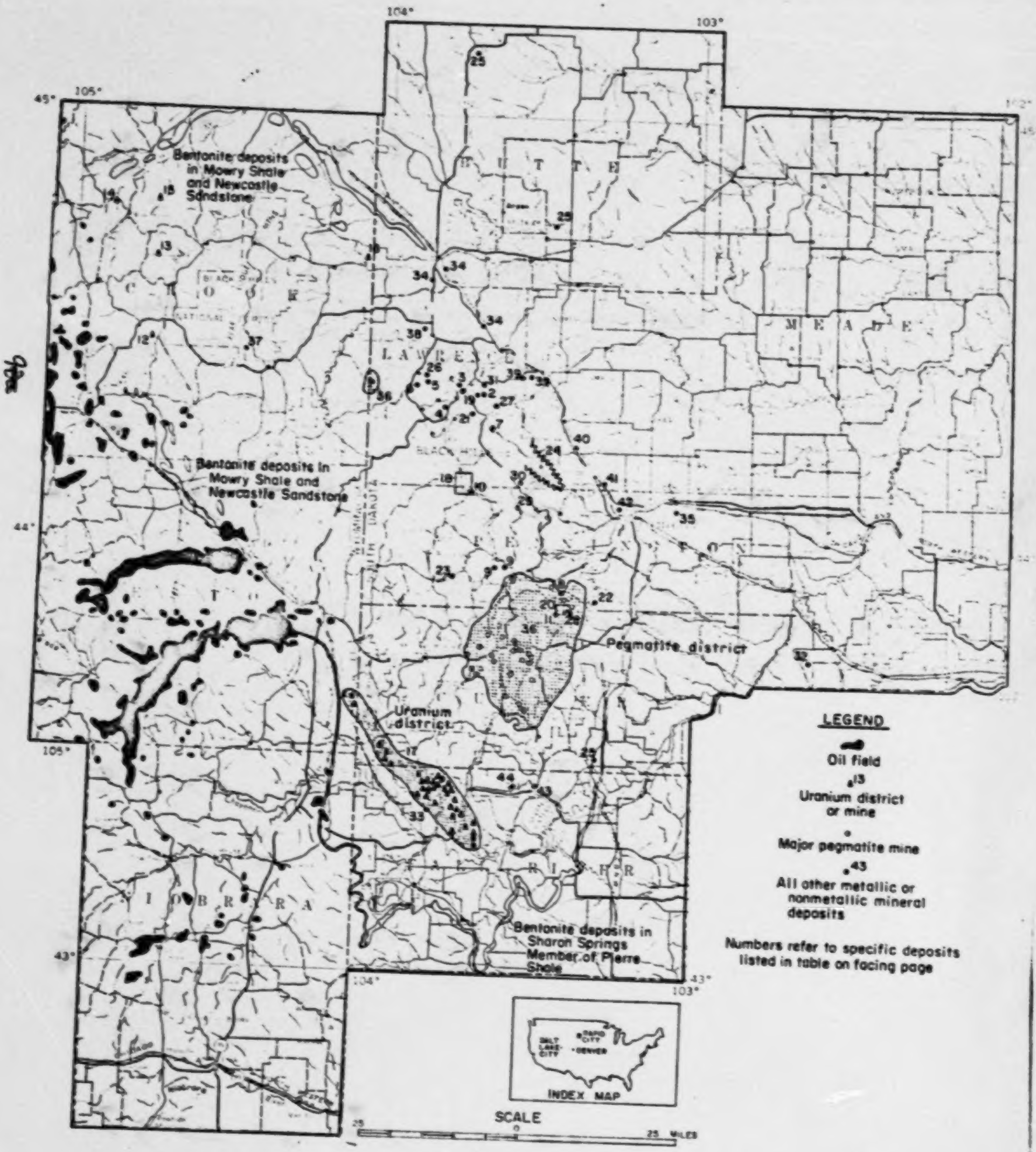
Portland cement, produced at the State-owned plant in Rapid City (photo 2), has been a valuable contributor to the Black Hills economy. A record 2.637 million barrels was shipped in 1961. In 1964, the plant used 439,013 tons of limestone, 119,908 tons of shale, 19,657 tons of gypsum, 4,471 tons of iron ore, and produced 2.044 million barrels of cement.

The value of stone (usually crushed rock) produced in 1964 was almost $2.5 million. All but three of the regularly operating quarries utilize Minnekahta Limestone, the outcrop of which completely encircles the mountainous area. Uses include road metal, aggregate for concrete, ballast, and manufacture of cement and lime. Because of the lack of

Table 23.—Mineral production, 1960-64, in Crook, Niobrara, and Weston Counties, Wyoming; and Butte, Custer, Fall River, Lawrence, Meade, and Pennington Counties, South Dakota

Commodity	First year of production	Peak years	Last year of production	Units reported	1960 Quantity	1960 Value	1961 Quantity	1961 Value	1962 Quantity	1962 Value	1963 Quantity	1963 Value	1964 Quantity	1964 Value
Bentonite 1/														
South Dakota	1915	1951	1965	Short tons)	650,842	$7,912,666	658,776	$7,771,365	728,514	$7,996,404	W	W	W	W
Wyoming	1926		do	do }										
Beryl	1914	1953	1964	do	169	89,355	238	129,575	144	76,854	(2/)	W	4	$ 1,138
Columbite-tantalite	1903	1928	1938	Pounds	-	-	-	-	-	-	-	-	-	-
Cement (shipments)	1925	1961	1965	376-pound barrels	2,348,953	7,414,833	2,637,317	7,715,076	2,360,509	7,566,419	1,913,576	$6,107,547	2,043,725	7,073,282
Clays (other)			do	Short tons	201,970	201,970	248,921	248,921	W	W	W	W	W	W
Coal														
South Dakota			1935	do	-	-	-	-	-	-	-	-	-	-
Wyoming	1889		1926	do	-	-	-	-	-	-	-	-	-	-
Copper	1889		1963	do	1	642	-	-	-	-	1	493	-	-
Feldspar	1923	1946	1965	Long tons	45,588	391,775	29,354	186,459	29,697	190,983	25,190	156,773	25,980	180,247
Gemstones	1906		do	Weight not recorded	-	15,369	-	9,580	-	10,312	-	19,137	-	(3/)
Gold	1876	1965	do	Troy ounces	554,771	19,416,985	557,853	19,524,925	577,232	20,203,120	576,726	20,185,410	616,913	21,591,955
Gypsum	1884	1956	do	Short tons	22,247	88,988	22,178	88,712	23,146	92,584	24,132	96,528	18,907	75,628
Iron ore	1893	1956	1962	Long tons	W	W	22,321	100,000	34,013	113,263	-	-	-	-
Lead	1889		1963	Short tons	-	-	(2/)	W	3	552	4	929	-	-
Lime	1888		1965	do	W	W	W	W	W	W	W	W	W	W
Lithium minerals	1898	1951	1964	do	-	-	-	-	W	W	W	W	W	W
Manganese ore	1897	1892	1942	do	-	-	-	-	-	-	-	-	-	-
Mica:														
scrap	1899	1946	1965	do	205	9,748	1,054	32,122	210	5,710	W	W	996	32,338
sheet	1879	1961-63	do	Pounds	30,087	145,154	18,113	37,466	2,085	12,060	10,000	300	-	-
Natural gas 4/				Million cubic feet	-	-	3,643	201,000	3,808	556,000	3,606	511,000	3,443	440,000
Natural gas liquids 5/														
LP gases				Thousand gallons	-	-	5,973	247,000	8,443	326,000	5,429	223,000	3,921	165,000
Natural gasoline				do	-	-	-	-	-	-	-	-	977	61,000
Petroleum (crude)														
South Dakota	1955		do	Thousand 42-gallon barrels	-	-	1	W	-	-	4	W	53	104,000
Wyoming	1887		do	do	10,718	25,852,000	12,281	30,702,000	10,633	26,477,000	10,440	26,100,000	11,364	28,751,000
Sand and gravel														
South Dakota			do	Short tons	1,094,700	833,900	1,752,300	1,245,200	3,111,000	1,888,200	3,069,400	2,707,000	2,032,000	1,364,000
Wyoming			do	do	4,500	4,200	272,700	121,300	76,200	76,200	366,000	394,090	143,000	143,000
Silver	1876		do	Troy ounces	108,119	97,853	127,427	117,805	113,052	122,661	117,301	150,042	132,981	171,964
Stone 1/														
South Dakota			do	Short tons)	1,631,211	2,569,179	1,516,715	2,048,008	1,748,254	2,385,468	1,879,286	2,761,665	1,518,965	2,416,130
Wyoming			do	do }										
Tin	1884	1884-93	1952	Long tons	-	-	-	-	-	-	-	-	-	-
Tungsten	1898	1917	1956	Short tons	-	-	-	-	-	-	-	-	-	-
Uranium														
South Dakota	1952		1965	do	W	W	43,588	494,512	W	W	W	W	W	W
Wyoming	do		do	do	84,034	1,528,000	75,932	1,463,759	93,333	1,671,486	73,454	1,296,051	93,188	1,509,459
Vanadium 5/														
South Dakota	1960		do	do	-	-	W	W	18	W	W	W	W	W
Wyoming	do		do	do	-	-	W	W	122	433,622	W	W	W	W
Zinc	1889	1942-48	1948	do	-	-	-	-	-	-	-	-	-	-
Undistributed (values indicated by symbol W)						636,873		579,660		750,007		10,211,181		10,600,861
Total mineral value						$67,109,490		$73,044,463		$70,954,905		$70,921,056		$74,662,972

W Withheld to avoid disclosing individual company confidential data.
1/ Combined figure for South Dakota and Wyoming.
2/ Less than ½ unit.
3/ No breakdown by county available in 1964.
5/ No breakdown by county available in 1960.


104°
103°
105°
45°
102°
44°
43°
BUTTE
MEADE
CROOK
LAWRENCE
PENNINGTON
WESTON
CUSTER
FALL RIVER
NIOBRARA
BLACK HILLS
Bentonite deposits in Mowry Shale and Newcastle Sandstone
Bentonite deposits in Mowry Shale and Newcastle Sandstone
Pegmatite district
Uranium district
Bentonite deposits in Sharon Springs Member of Pierre Shale
LEGEND
Oil field
Uranium district or mine
Major pegmatite mine
All other metallic or nonmetallic mineral deposits
Numbers refer to specific deposits listed in table on facing page
SALT LAKE CITY
RAPID CITY
DENVER
INDEX MAP
SCALE
25
0
25 MILES

90a

MAP 8. MINERAL RESOURCES

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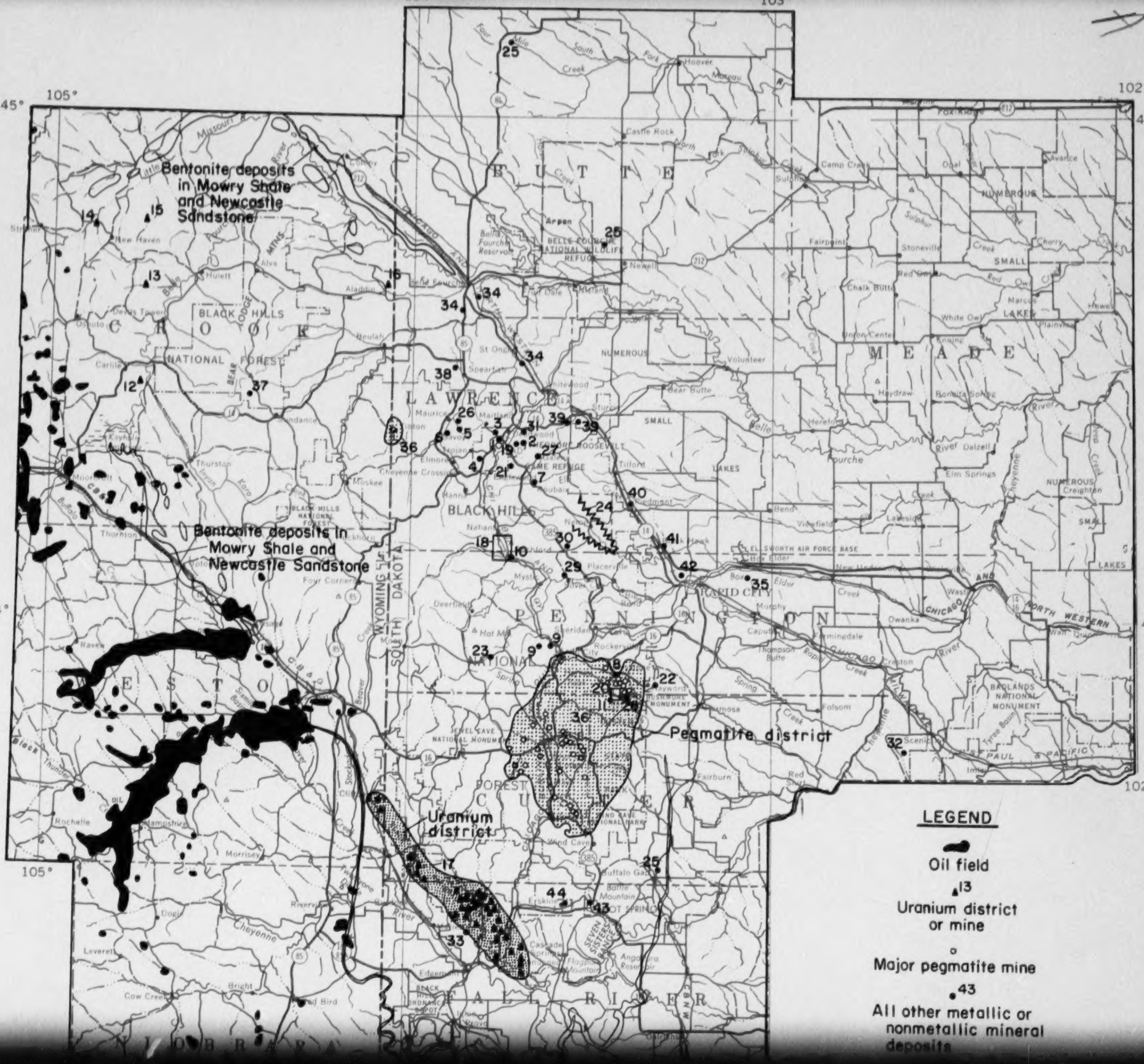
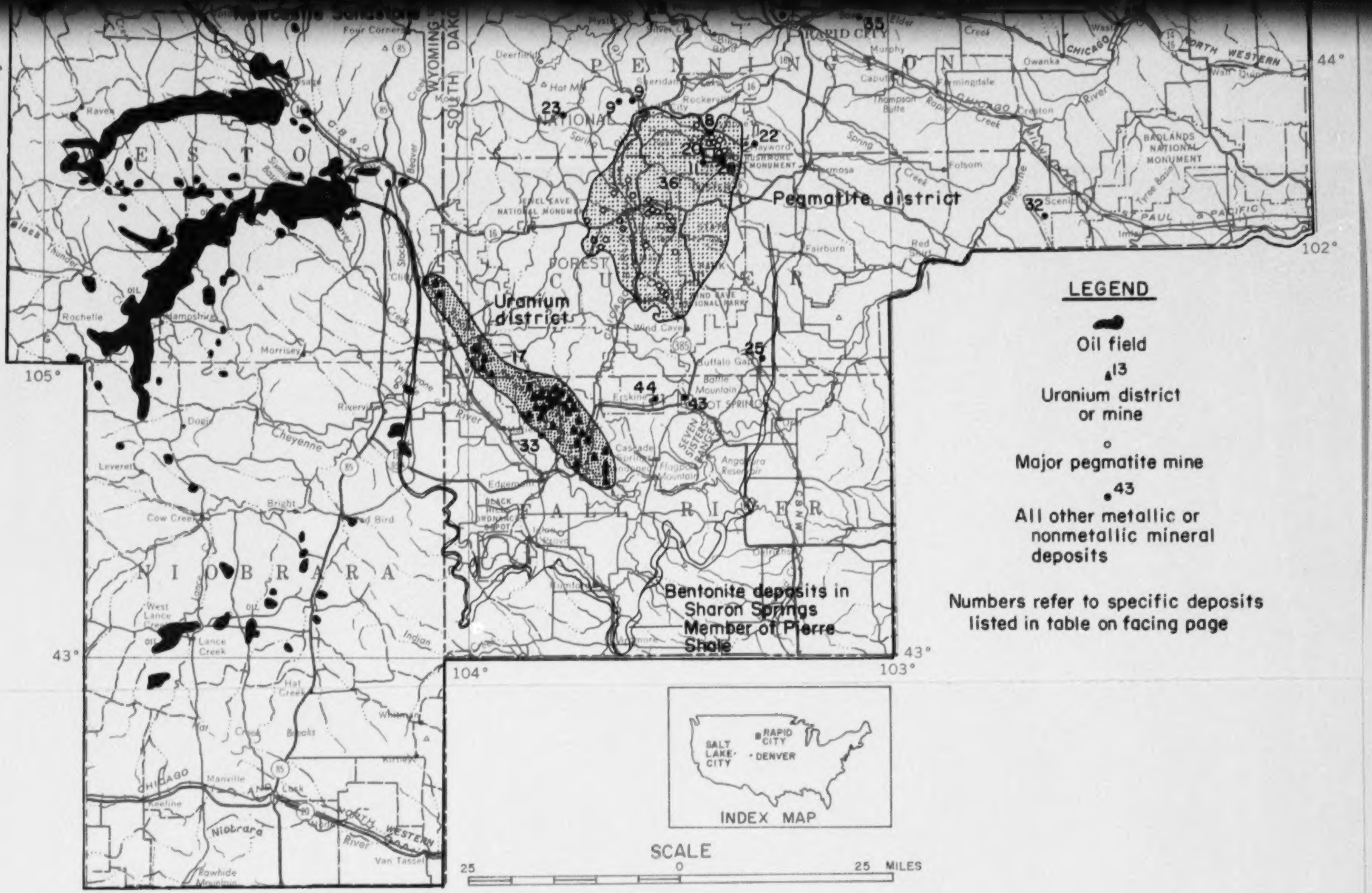
See following page
for greater detail.
xxxxxxxxxxxxxxxxxxx

90a

A


104°
103°
105°
102°
45°
44°
Bentonite deposits in Mowry Shale and Newcastle Sandstone
Bentonite deposits in Mowry Shale and Newcastle Sandstone
Pegmatite district
Uranium district
BUTTE
MEADE
LAWRENCE
PENNINGTON
CROOK
WESTON
CUSTER
FALL RIVER
NIOBRARA
BLACK HILLS
BLACK HILLS NATIONAL FOREST
WYOMING
SOUTH DAKOTA
RAPID CITY
ELLSWORTH AIR FORCE BASE
BADLANDS NATIONAL MONUMENT
JEWEL CAVE NATIONAL MONUMENT
BELLE FOURCHE NATIONAL WILDLIFE REFUGE
HOT SPRINGS
LEGEND
Oil field
13
Uranium district or mine
Major pegmatite mine
43
All other metallic or nonmetallic mineral deposits



MAP 8. MINERAL RESOURCES

B

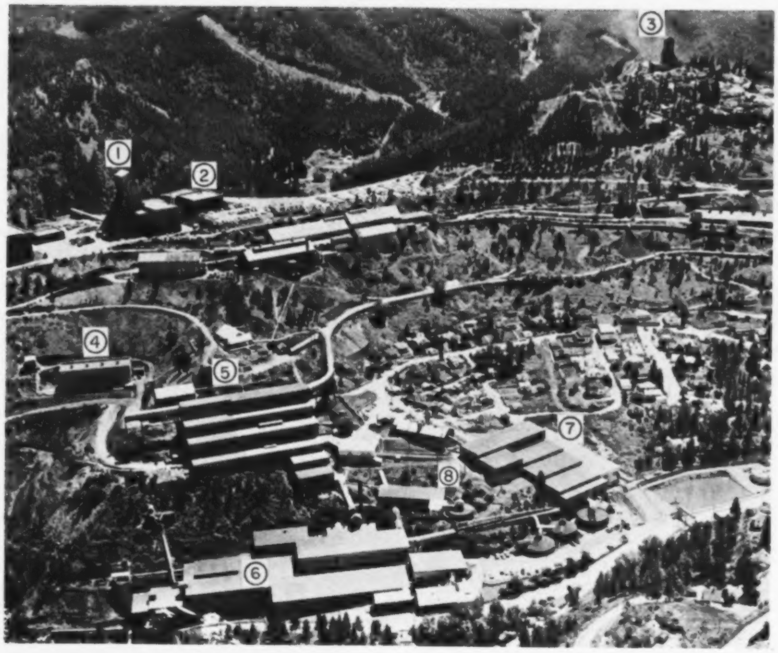


Photo 1. Aerial view of Homestake Mining Company surface plant at Lead in Lawrence County, South Dakota. Major plant units are: (1) Yates shaft and hoisting plant; (2) company offices; (3) Ross shaft and hoisting plant; (4) compressor building; (5) south mill; (6) east cyanide plant; (7) west cyanide plant; (8) gold refinery.

Photo 2. Cement plant near Rapid City, operated by South Dakota State Cement Commission.

other good rock, and the scarcity of nonalkali-reactive gravels in the surrounding area, this limestone is shipped by rail or truck for distances exceeding 200 miles.

The sixth most valuable mineral production in 1964 was uranium. All uranium in the nine-county area has come from Cretaceous sandstone ore bodies. The principal minerals are carnotite, tyuyamite, rauvite, corvusite, and coffinite. The discovery of uranium ores was made in the fall of 1951, and the first ore was shipped to Rifle, Colorado, in January 1952. An Atomic Energy Commission purchasing station was established at Edgemont, South Dakota, in 1955. The most productive areas have been in western Fall River County, north of Edgemont, and on the northwestern flank of the Black Hills in Crook County, Wyoming.

Sand and gravel production ranked seventh in value in 1964. All nine counties have produced sand and gravels suitable for highway construction. The gravels are found on the high terraces surrounding the mountains, or are associated with the present-day streams. Most of this gravel is dirty and alkali-reactive.

Masonry-grade sand and gravel is obtained from terraces and floodplain deposits of Battle Creek and the Cheyenne and Belle Fourche Rivers.

Iron, though a low-value product in 1964, should be listed here because of the extensive deposits. Five types have been developed on a small scale in the past. These are (1) recent bog iron deposits in the Rochford-Nahant area, Lawrence and Pennington Counties; (2) hematite ores of the basal Deadwood Formation in the Strawberry Hill-Two Bit area, Lawrence County; (3) pyritic deposits of the Precambrian and Cambrian rocks in Lawrence County; (4) Precambrian specularite-martite-magnetite-taconite deposits of the Nemo area, Lawrence County; and (5) a hematite mass associated with Precambrian iron-rich schists at Iron Mountain on the Pennington-Custer County line. Minor quantities of these deposits have been used as paint pigment, as a flux for smelting refractory gold ores of the Deadwood Formation, and as additives in manufacturing cement.

Other mineral production of somewhat lesser value in 1964 included feldspar, silver, gypsum, mica, and gemstones.

Feldspar mining has been a relatively steady industry in the area since adjustment of freight rates in 1923 permitted it to enter Eastern markets at competitive prices. In the peak year of 1946, 75,000 tons was shipped from the area. Current production is roughly 27,000 tons per year. Feldspar is used primarily in the ceramic porcelain and glass industries, and small quantities are used as a mild abrasive in scouring compounds.

Early-day production of silver came from such camps as Carbonate, Galena, Spokane, and Silver City. Most of the silver properties closed when the price of silver dropped in 1891. Periodic efforts to reopen some of these mines have not been successful. In recent years, the only appreciable production of silver has come as a byproduct of gold mining. Homestake Mining Company produced 133,000 ounces of silver with its gold bullion in 1964.

Gypsum crops out in beds 10 to 30 feet thick in the Spearfish Formation encircling the mountains and vast tonnages are available from outcrops of the Minnelusa Formation in Crook County. At present, only about 20,000 tons per year is produced. It is mined near Rapid City and used as a retarder in cement manufactured by the State Cement Commission.

Pegmatites in the southern mountains have yielded high-grade sheet mica intermittently since 1879, and scrap mica has been recovered as a byproduct of other pegmatite mining since 1899. With the closing of a Government-sponsored mica-rifting plant at Custer and the termination of the support program in 1962, sheet mica production has dropped to virtually nothing.

Rocks sought by collectors in the area for gemstones include the pegmatite minerals of rose quartz, spodumene, beryl, apatite, tourmaline, and feldspar, and such silica minerals as jasper, chalcedony, agate, petrified wood, and cycads. Golden barite, garnet, specularite, andalusite, and alabaster are also found. Much of the material is used as display specimens; the remainder is cut and polished, tumbled, or carved. Because the collection and sale of gemstones is largely a hobby of amateurs, production figures are not available. The Bureau of Mines estimates production from the area at about $20,000 per year. It is probable that money spent by local "rockhounds" and visitors exceeds the intrinsic value of the material collected.

Other minerals of relatively lesser importance include beryl, columbite-tantalite, other clays (not bentonite), coal, copper, lead, lime, lithium, manganese, tin, tungsten, vanadium, molybdenum and zinc.

One of the most interesting mineral production histories concerns lithium used in pharmaceuticals and in the glass and ceramics industries. The Black Hills area was the principal source of the world's lithium from 1898 to 1952. Because of the development and milling of extensive low-grade deposits in Canada and North Carolina, and imports from Rhodesia, local operations lost their competitive advantage. The spodumene flotation mill of the Lithium Corporation of America at Hill City closed in 1956 and the Etta mine at Keystone, which had produced hand-cobbed spodumene since 1898, closed in 1960. Since then, production has been negligible.

Mineral Processing

The various field processing facilities maintained by the petroleum industry extend from the wellhead to the refinery. They include pumping, treating, and gathering facilities; pipelines and pumping stations; plants for recovering natural gasoline and liquefied petroleum products from gas; and pumping facilities for injecting gas or water back into reservoirs for repressuring purposes.

Sioux Oil Company at Newcastle has recently enlarged and modernized its refinery and now processes 7,500 barrels of crude oil per day. Products include gasoline, diesel fuel, jet fuel, lubricants, and heating oils, most of which are marketed within 100 miles of the refinery. The operation requires an average of 375,000 gallons of water per day, derived from the company's own 3,465-foot well. The C. & H. Refinery operates a small skimming plant at Lusk, Wyoming, with five employees. Throughput of this refinery in 1964 was reported to be 16,830 barrels.

Three natural gas plants were operated in 1964. They processed more than 8 million cubic feet of natural gas yielding 16,900 gallons of combined natural gasoline and LP gases in an average day.

Capacity of the Homestake mine and mills at Lead and Deadwood has been gradually increased. They now treat a total of 5,555 tons of ore per day. Metallurgical recovery of the gold averaged 96.24 percent during 1964. Bullion is shipped by express to the United States Mint at Denver, Colorado. The Homestake Mining Company employed 1,777 people in 1964.

In processing bentonite, the overburden is stripped off and the bentonite is turned over and stored in place for several weeks or months to permit natural reduction of moisture content. Then the crude bentonite is loaded into trucks and hauled to the mills, which dry, grind, and size it. Drying is done in rotary kilns fired with gas or fuel oil. The finished clay is either sacked or shipped in bulk. All plants rely on wells to supply their small water requirements. Three plants in Weston and one in Crook County (closed in 1965) are located on the Chicago, Burlington and Quincy Railroad. Two in Butte and two in Crook County are situated on a spur of the Chicago and North Western Railway, which extends from Belle Fourche, South Dakota, to Colony, Wyoming.

The State-owned cement plant at Rapid City has grown from a rated capacity of 2,000 barrels per day in 1925 to the present capacity of 10,000 barrels per day, or 3.5 million barrels per year. Shipments in 1964 exceeded 2 million barrels. In 1964, 17.7 kw.-hr. of electricity and 1,081,966 B.t.u. of fuel were consumed for each barrel of cement produced. Water for the plant is drawn from three 200-foot artesian wells. The plant employed 184 people during 1964.

Several stone quarries, favorably situated with regard to market and transportation, have operated continuously for many years. On the west side, quarries near Newcastle and Sundance, Wyoming, supply local demand for crushed limestone. On the South Dakota side, seven quarries supply stone to the trade. South Dakota State Cement Plant processes more than 430,000 tons of rock a year, but uses it all in its own operation. Rapid City and Lead both operate their own rock quarries. In 1964, the total rock produced within the nine-county area was 1,519,000 tons.

A uranium mill at Edgemont, South Dakota, was completed in late 1955. Originally built to process 250 tons per day by the acid-leaching, resin-in-pulp process, its capacity was gradually increased to 542 tons per day in 1964. A vanadium recovery circuit was added in 1960, and a molybdenum recovery unit was added in 1963. The final product is yellow cake (U_3O_8 concentrate) which is barreled and shipped to the Atomic Energy Commission for further processing. In 1964, the operation employed an average of 62 people. The AEC contract for the purchase of uranium concentrates from the Edgemont Mills of Mines Development, Inc., expires in fiscal year 1967, and mill operation after that depends on the ability of the company to sell its product to private industry.

Most masonry-grade sand and gravel is produced at Wasta, Pennington County, and at Oral, Fall River County, South Dakota. Portable equipment is used at all pits opened for gravels used on nearby highways. At the peak of the season, about 33 men are employed in these scattered operations.

Energy Used by the Mineral Industry

The mineral industry is a substantial user of electric power. The estimated use in 1964 probably exceeded a quarter of a billion kilowatt-hours. The Homestake Mining Company alone accounted for almost 95 million kilowatt-hours—the petroleum industry for another 66 million kilowatt-hours.

Other sources of energy used by the mineral industry include natural gas, fuel oil, coal, diesel fuel, and sawdust. In 1964, the cement, clay products, gold mining and bentonite used more than 3.1 billion cubic feet of gas and almost 3 million gallons of fuel oil. The Homestake Mining Company burned 14,078 tons of Wyodak coal during that year.

Local Mineral Consumption

The only minerals produced in the Black Hills area but not consumed largely within South Dakota, Wyoming and adjacent States, are bentonite, gold, pegmatite, and uranium. In 1964, the Black Hills area produced 40 percent of the gold, 49 percent of the Wyoming-type bentonite, 4 percent of the feldspar, and 3 percent of the uranium in the United States.

Two of the minerals present in the nine-county area in near-commercial quantities are actually imported rather than produced from local supplies. They are coal and gypsum. Coal used in the Black Hills area is mined only 15 miles west of Crook County under ideal conditions that cannot be duplicated closer to the Hills. Repeated surveys within the past 20 years have shown that it is more economical to mine and process gypsum for plaster-of-Paris, sheetrock, and other gypsum products in adjacent Montana than in the Black Hills area.

RECREATION

Recreation is the newest of the major resource fields in the area. Tourist use began early in the century but did not assume any significant importance until the 1920's. The greatest growth of the industry has occurred since World War II and recreation expenditures now are estimated to exceed $75 million.

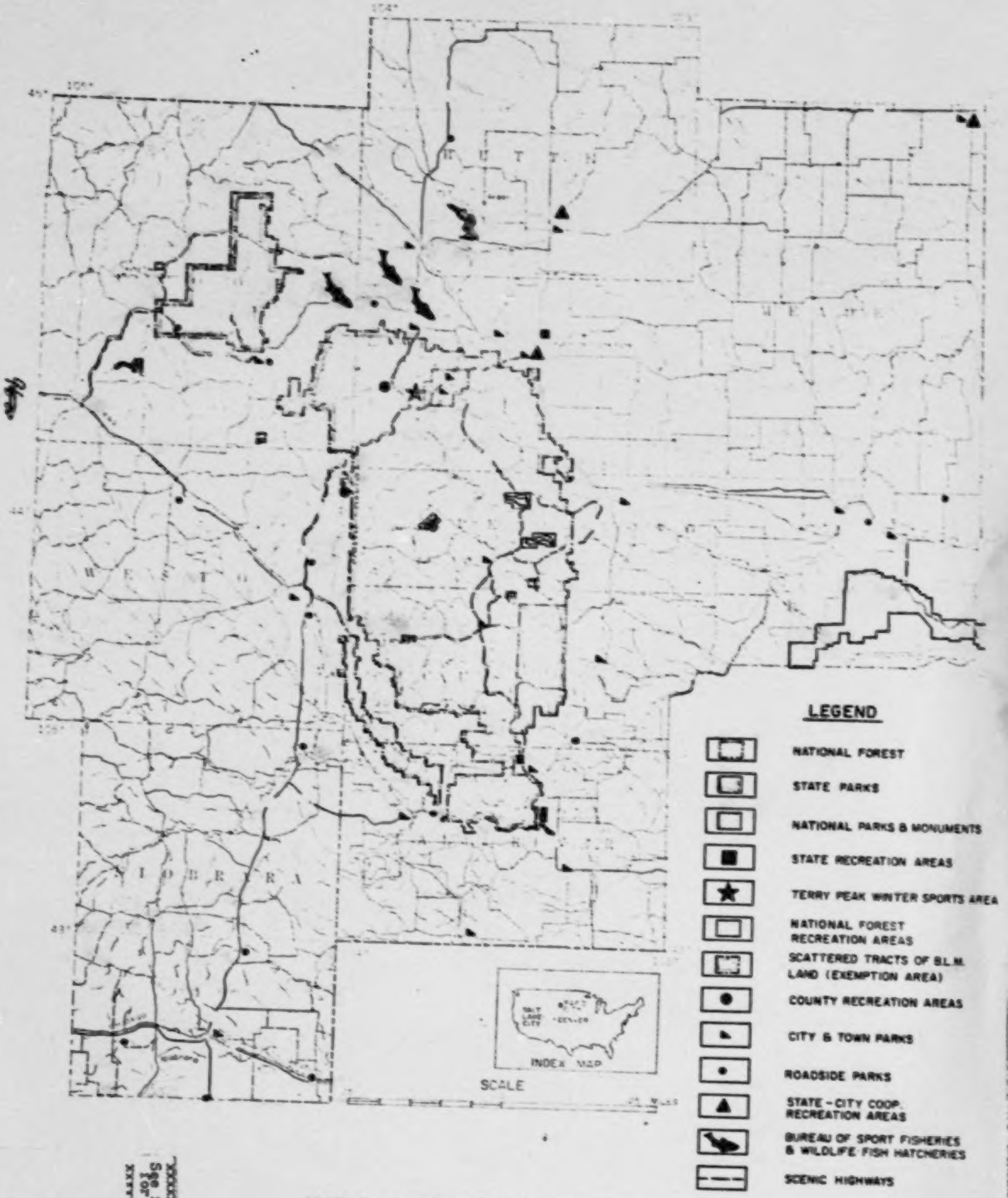
Public Recreation Resources

Within the nine-county study area, the Hills portion is the real drawing card for recreationists. This forested region, a compact 40 miles wide by 85 miles long, supports a tremendous amount of recreation activity and contains many varied and interesting scenic features. The greatest concentration of recreation activity is in the central Hills around Mount Rushmore National Memorial. The second and third most important concentrations are found in the northern and southern Hills, respectively. The western Hills area has had little development and lacks good, paved roads. Map 9 shows locations of primary attractions.

Major recreation areas lying outside of the Hills are Badlands National Monument to the east; the Bear Lodge Mountains area of the Black Hills National Forest, Devils Tower National Monument, and Keyhole Reservoir to the west in Wyoming; Belle Fourche Reservoir and Bear Butte State Park to the north; and Angostura Reservoir to the south. Other smaller State and community sites are scattered rather widely throughout the entire area. In fact, most of the area is used for hunting, fishing, or some form of recreation at one time or another each year.

Several Federal and State agencies, plus two counties and 16 communities, offer outdoor recreation developments or attractions. The Black Hills National Forest, National Park Service areas in South Dakota, and Custer State Park, however, provide the basic recreation resource of the area.

The Black Hills National Forest and two national grasslands administered by the Forest Service offer more acres, variety, and basic facilities to the recreationist than any other major land areas in the


LEGEND
NATIONAL FOREST
STATE PARKS
NATIONAL PARKS & MONUMENTS
STATE RECREATION AREAS
TERRY PEAK WINTER SPORTS AREA
NATIONAL FOREST RECREATION AREAS
SCATTERED TRACTS OF B.L.M. LAND (EXEMPTION AREA)
COUNTY RECREATION AREAS
CITY & TOWN PARKS
ROADSIDE PARKS
STATE-CITY COOP. RECREATION AREAS
BUREAU OF SPORT FISHERIES & WILDLIFE FISH HATCHERIES
SCENIC HIGHWAYS
INDEX MAP
SALT LAKE CITY
DENVER
SCALE
WESTON
NIOBRARA

MAP 9. PUBLIC RECREATION AREAS

See following page
for greater detail.

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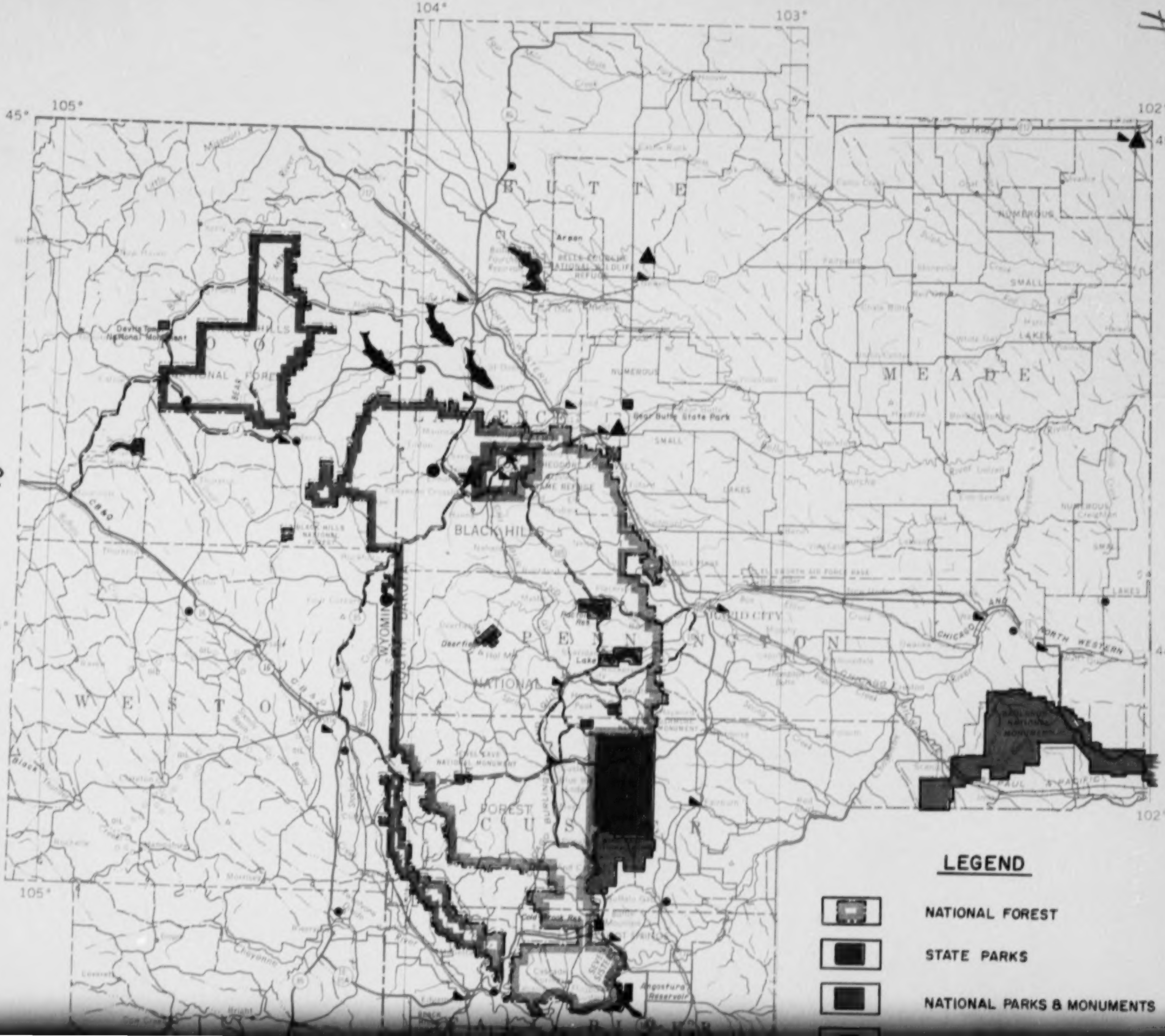
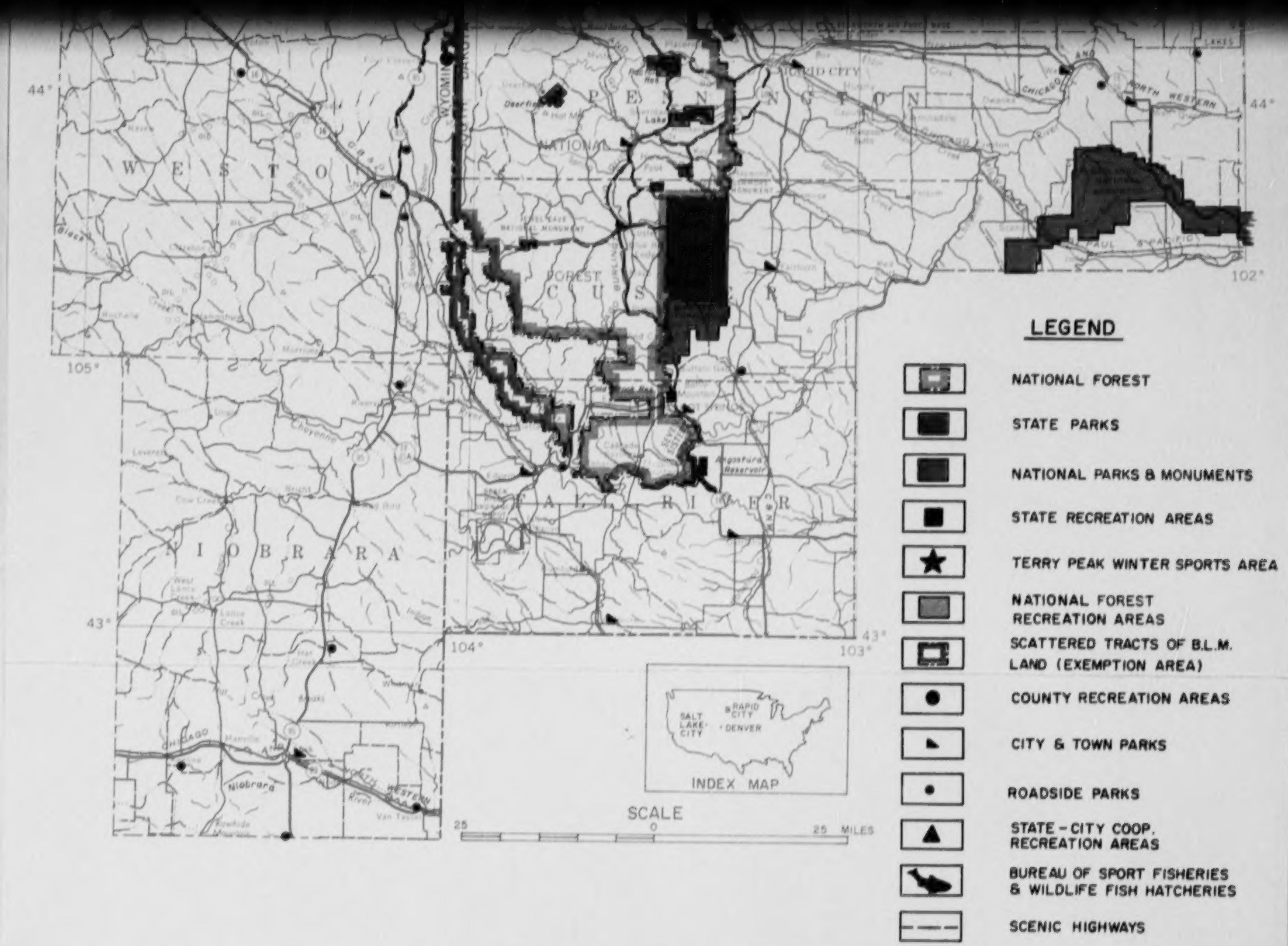

LEGEND
NATIONAL FOREST
STATE PARKS
NATIONAL PARKS & MONUMENTS
104°
103°
105°
102°
45°
44°
B U T T E
M E A D E
L A W R E N C E
P E N N I N G T O N
C U S T E R
W E S T O N
C R O O K
BLACK HILLS
NATIONAL
FOREST
Belle Fourche National Wildlife Refuge
Arpan
Bear Butte State Park
Devils Tower National Monument
RAPID CITY
Ellsworth Air Force Base
Jewel Cave National Monument
Angostura Reservoir
Badlands National Monument
Chicago and North Western
SOUTH DAKOTA
WYOMING
NUMEROUS
SMALL
LAKES

96a



MAP 9. PUBLIC RECREATION AREAS

B

region. Most of the opportunity is provided in the national forest, with nearly 1.2 million acres of recreation-oriented land available. It is especially noted for its extensive acreage of pine-clad rolling hills, scenic roads, interesting rock formations, and numerous camp and picnic sites. Other primary attractions include major water-oriented recreation areas around Sheridan Lake and Pactola and Deerfield Reservoirs. Natural attractions of the forest are outstanding and consist of streams, scenic areas (Harney Peak and several interesting canyons), historical sites, and geologic areas (including caves); several of these are undeveloped.

The Buffalo Gap and Thunder Basin National Grasslands, located southeast and southwest, respectively, of the Hills, are large, plains-situated grazing lands that offer limited recreation opportunities except for hunting.

The National Park Service administers five recreation areas of national renown in the nine counties. They are Wind Cave National Park, Mount Rushmore National Memorial, and Badlands, Devils Tower, and Jewel Cave National Monuments. All but Jewel Cave offer visitor centers, scenic drives, nature trails, and evening programs; modern camp and picnic sites are available at all but Mount Rushmore and Jewel Cave. Wildlife species, large and small, hold special interest for the visitor at Wind Cave National Park and Badlands National Monument, and to a lesser extent at the other areas.

The Badlands present a weirdly beautiful, eroded landscape. Devils Tower is a spectacular 1,000-foot-high volcanic plug in the form of a cluster of rock columns. Mount Rushmore, the best known attraction in the area, features gigantic carvings of the faces of four United States Presidents. The Wind Cave and Jewel Cave areas contain interesting and beautiful caverns.

Public domain areas administered by the Bureau of Land Management are scattered tracts located in all nine counties. Except for the "exemption area" surrounding Deadwood and Lead, and the Fort Meade area southeast of Sturgis, most of the tracts are nonforested, scattered, and primarily valued for grazing. They offer extensive hunting but no developed recreation sites or major water areas.

The Bureau of Sport Fisheries and Wildlife provides opportunities for recreationists to see trout in rearing ponds and to observe hatchery procedures at the McNenny and Spearfish National Fish Hatcheries near Spearfish, South Dakota, and the Fish Genetics Laboratory at Beulah, Wyoming.

State recreation areas are important in the Black Hills. Especially significant is South Dakota's Custer State Park comprising 72,000 acres of spectacular scenery in the Hills southwest of Rapid City. Particularly beautiful and unusual are the "Needles" rock formations and the Sylvan Lake area. Other attractions in the park include four popular recreation lakes; a variety of wildlife, including bison; an historic museum and "restored" stockade; a zoo; a playhouse; an observation tower; and scenic drives and trails. Facilities in Custer State Park include park-owned, concessionaire-operated lodges and cabins at Blue Bell, Sylvan Lake, Legion Lake and Game Lodge, as well as ten popular camp and picnic sites. Swimming, boating, riding horses, and jeep rides are provided at several locations. Operating funds have been obtained largely from camping and picnicking fees, a park user charge, sales of bison and bison meat, timber sales, and from concession operations.

In addition to Custer State Park, the South Dakota Department of Game, Fish and Parks maintains recreation areas at Angostura and Cold Brook Reservoirs, at Bear Butte State Park, at a sizable number of public fishing access and shooting areas; and it shares in the provision of five roadside parks and several "cooperative" recreation areas. Cleghorn Springs State Fish Hatchery also provides ample opportunities for recreationists to observe hatchery procedures.

An outstanding aspect of the recreation opportunities of the area are the many miles of scenic highways. Some twist and turn through drainages, around "pigtail" turns, across log bridges, and through

Photo 3. Unusual rock formations present an outstanding attraction in the central Hills area. Shown here are Sylvan Lake, with Harney Peak in the background.

narrow one- and two-lane tunnels, creating a maximum of interest and a minimum of ground disturbance.

Recreation facilities provided by the State of Wyoming include a State park at Keyhole Reservoir, the Sand Creek Public Fishing Area, and ten roadside parks maintained by the Highway Department. Keyhole Reservoir offers excellent fishing, boating, and water skiing.

Community and county parks provide many intensive recreation facilities such as swimming pools, golf courses, playfields, camp and picnic sites, fairgrounds, children-oriented parks, local historic sites, and museums. The communities of Rapid City, Custer, Hot Springs, Sturgis, Whitewood, Spearfish, Belle Fourche, Faith, Newell, and Deadwood-Lead in South Dakota, and Newcastle and Lusk in Wyoming, provide the bulk of community park acreage. County parks are found in Lawrence and Weston Counties.

A number of city parks are heavily used for picnicking and several are designed for and used by campers. A notable example is the 130-unit City Campground at Spearfish.

"Other" noncommercial and nongovernment organizations are beginning to provide limited recreation facilities. The Veterans of Foreign Wars, for example, has applied to the Bureau of Land Management for a lease to develop a small picnic and rest stop adjacent to the national cemetery near Sturgis. Belle Fourche Reservoir, administered by the Belle Fourche Irrigation District, is currently the most important area in this "other" category. It has no recreation facilities but is extensively used for fishing, boating, and water skiing.

Recreation use of all kinds and affecting all public sectors has been gradually increasing in the area for the last 20 years at an average rate approaching 10 percent a year.

Table 24 summarizes the kinds and quantities of recreation developments in the Hills administered by Federal, State, and local governments. Visitations to these public areas are illustrated in graph 14.

Private Recreation Resources

Privately supplied recreation in the Black Hills is a large, complex, and highly competitive business. As with the public sector, most private developments are concentrated in or on the outskirts of the Hills (map 10). In addition, they are clustered in communities and strung out along the main highways. Development can be grouped into five general categories: (1) Hotels, motels, and lodges; (2) private campgrounds and trailer parks; (3) attractions; (4) rides and tours; and (5) game and sports developments.

Hotels, motels, and other lodging facilities are mostly concentrated in or near larger towns. Motels provide the bulk of lodging

Table 24.—Summary of primary public recreation developments

Development	Federal		State				Local gov't.		Total	
			S. Dak.		Wyo.					
	Sites	Units	Sites	Units	Sites	Units	Sites	Units	Sites	Units
Boat launch or access	5	-	7	-	-	-	3	-	15	-
Swim beach or pool	3	-	4	-	-	-	9	-	16	-
Picnic	34	334	14	93	13	39	32	740	93	1,206
Tent or trailer camp	36	1,019	13	225	2	10	7	205	58	1,459
Hotel, lodge & cabin	2	38	6	187	-	-	1	36	9	261
Group camping	1	150	-	-	-	-	3	86	4	236
Organization camp	1	14	-	-	-	-	1	48	2	62
Ski slope	1	-	-	-	-	-	-	-	1	-
Vista point	27	-	9	-	2	-	2	-	40	-
Visitor center & museum	5	-	3	-	-	-	10	-	18	-
Information point	3	-	4	-	-	-	10	-	17	-
Amphitheater	5	-	-	-	-	-	-	-	5	-
Playfield	-	-	1	-	-	-	20	-	21	-

space. The typical motel in the area is locally owned and operated and contains fewer than 30 units. There are nearly 400 lodging establishments in the area, having more than 7,000 units or rooms and a capacity of about 30,000 people.

Next to service stations and restaurants, lodging businesses earn more of the tourist dollar than any other group. The short, high-impact season, however, often seriously reduces profits. Many motels close during the winter months.

There are probably more privately operated campgrounds and trailer parks per square mile in the Hills than in any other comparable area in the Western United States. This business has grown rapidly in the last 10 years. There are 55 to 60 privately owned campgrounds and trailer parks, with about 3,200 family units for a capacity of 15,000 people. The average development contains 50 units, charges $1.75 to $2.00 per family, and returns only a modest profit. The most successful operations are located near main travel routes and provide a full range of extra services and facilities. Complete trailer "hook ups", a swimming pool, showers, a store, laundromat, snack bar, recreation buildings, and even evening programs and touring services may be provided.

GRAPH 14. RECREATION USE-PUBLIC AREAS

VISITS AT RECREATION AREAS OF THE FOREST SERVICE, NATIONAL PARK SERVICE, AND SOUTH DAKOTA GAME, FISH AND PARKS DEPARTMENT FOR THE PERIODS. 1950 1950-1955 1955-1960 1960-1964

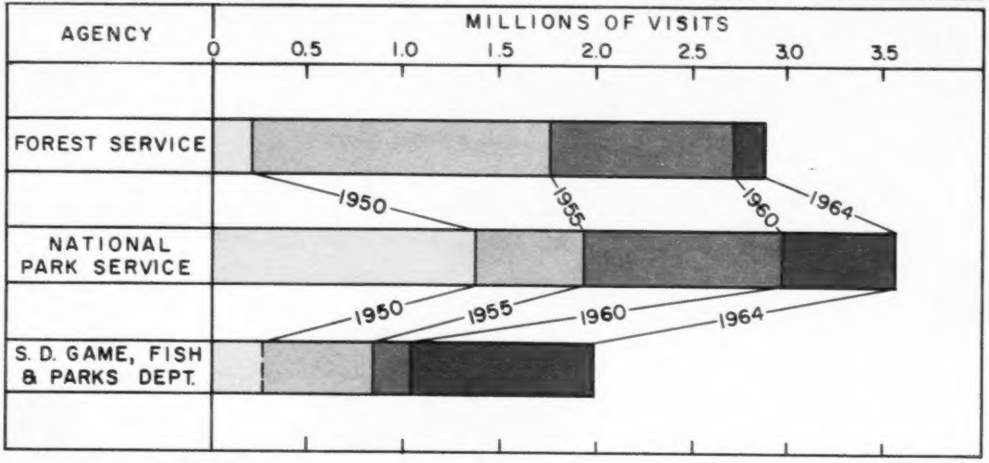
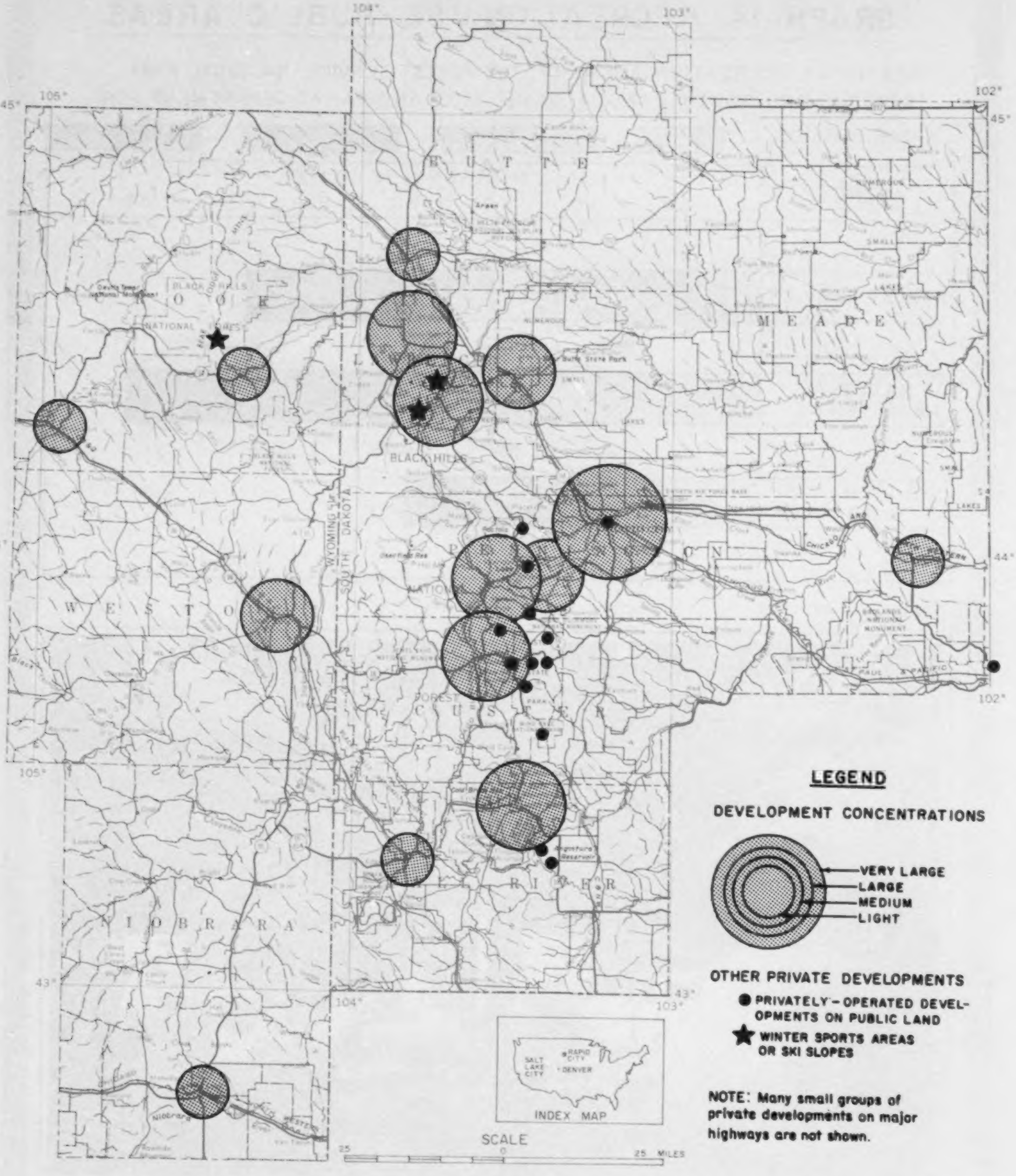


Photo 4. Public recreation areas in the Black Hills region have experienced a steady but tremendous increase in use over the past 15 years. During this period, camping visits at recreation areas of the three agencies listed in Graph 14 increased from just over 50,000 to nearly 500,000.


104°
103°
105°
102°
45°
44°
43°
BUTTE
MEADE
CROOK
PENNINGTON
WESTON
CUSTER
FALL RIVER
NIOBRARA
WYOMING
SOUTH DAKOTA
BLACK HILLS
LEGEND
DEVELOPMENT CONCENTRATIONS
VERY LARGE
LARGE
MEDIUM
LIGHT
OTHER PRIVATE DEVELOPMENTS
● PRIVATELY-OPERATED DEVELOPMENTS ON PUBLIC LAND
★ WINTER SPORTS AREAS OR SKI SLOPES
NOTE: Many small groups of private developments on major highways are not shown.
SALT LAKE CITY
RAPID CITY
DENVER
INDEX MAP
SCALE
25
0
25 MILES

MAP 10. PRIVATE RECREATION AREAS

The variety of private attractions in the Black Hills is enormous, ranging from the spectacular to the commonplace. Included are: (1) museums, memorials, and historic points; (2) mines and gold panning sites; (3) playhouses, pageants, and historical shows; (4) gravity houses; (5) zoos and animal, fish and reptile exhibits; (6) fishing ponds; (7) caves and waterfalls; (8) rock houses and curio shops; and (9) "villages" and other exhibits for children. Most of the attractions are entirely man-made and have some tie-in with the history or Western flavor of the area. There is also a considerable amount of recreation activity furnished by privately owned hunting areas and farm and ranch ponds. The many signs and wide range in quality of the attractions in some areas often create a semicarnival atmosphere. Yet, the average visitor seems pleased with the great number of things to do and see, and studies indicate more than half return.

Rides and tours are growing rapidly in popularity and importance. They include wagon, jeep, and helicopter rides; tours by limousine or bus; an historic narrow-gage train ride to Oblivion, South Dakota; and chairlifts and tramways.

Game and sports developments, notably swimming pools and golf courses, were originally built more for resident than tourist use, but tourist use is growing. There are now about a half dozen large, privately operated swimming pools and many smaller ones, and nine privately owned golf courses.

The Terry Peak, Warren Peak, and Maitland Slopes winter sports areas are used almost exclusively by residents. They have short seasons during some years because of insufficient natural snow.

Concern over competition between private and public campgrounds has increased in direct proportion to the investment growth in privately operated facilities. The more primitive sites are finding themselves in competition with older campgrounds provided by Federal and State agencies. Private operators with more or less completely developed sites are now meeting a need unsatisfied by the various public agencies. Some competition will undoubtedly remain for a time between certain older public sites and the less-well-developed private enterprises.

Records obtained from eight major private attractions clearly indicate a steady upward trend in use of the private recreation resources (table 25). The average increase in use of private recreation facilities has been estimated at almost 10 percent per year over the past 10-year period.

Analysis of Recreation Use

Ten outdoor recreation activities are considered to be of primary importance in the Black Hills. They are (listed in decreasing order of popularity) the land-based activities of sightseeing, camping, hiking,

Photo 5. More people are hiking and even strolling, but opportunities are limited at present.

Photo 6. More privately operated campgrounds are providing a complete range of special facilities and conveniences. The pride of this campground is a deluxe restroom, shower and laundromat building.

Table 25.—Visitation at selected attractions, 1960-65

Attractions	1960	1961	1962	1963	1964	1965
			(in thousands)			
S. D. School of Mines Museum	40	45	47	54	58	60
Sioux Museum, Rapid City	37	43	49	57	64	NA
Reptile Gardens	203	181	214	226	216	234
Passion Play	86	81	85	96	97	108
Homestake Mine Tour	50	45	52	63	65	66
Rockerville Gold Town	169	171	197	209	230	NA
Story Book Island	-	251	273	280	282	283
Adams Museum, Deadwood	78	101	108	120	134	172

NA: Not available.

picnicking, hunting, and winter sports; and the water-based activities of swimming, fishing, boating, and water skiing. Other less significant activities include horseback riding and attending outdoor drama, concerts, and programs.

Trend studies indicate that the popularity of most day-use activities, especially hiking, swimming, boating, water skiing, and fishing, is increasing. Sightseeing and most other activities remain steadily high in popularity, and use of camping facilities is much greater than might be expected from national or regional averages. Fishing, though still a favorite sport, has suffered through loss of water and quality. Most fishing now occurs on impounded water rather than on streams. Local residents continue to contribute the greatest impact in picnicking, fishing, hunting, and swimming, but this seems to be changing. Boating and water skiing are definitely resident sports—less than 2 percent of the tourists transport boats into the area.

Surveys show that August is the most popular vacation month, with July next. Use is extremely light in May and September, often beautiful months. About half of the visitors have been to the Black Hills before. They follow plans made at least three months in advance, selecting the shortest travel routes or the most convenient to their destination. For this reason, lesser known, out-of-the-way attractions are seldom heavily used.

Most out-of-State visitors stay in motels or lodges, but nearly as many stay in tourist or private homes. Together, these categories account for about 70 percent of tourist nights. Campgrounds host about 25 percent. Of the camper group, about a third stay in tents; more than 20 percent use travel trailers, and the rest utilize pickup coaches, tent trailers, station wagons, and other equipment.

The average tourist car contains 3.6 people. The average family arrives between Sunday afternoon and Monday evening and stays about two days in the area. They are on a two-week vacation and spend about $10 a day for each person in the car. Surveys conducted in national forest campgrounds show that about 15 percent of the users are from South Dakota and less than 2 percent from Wyoming. About half of the South Dakota and Wyoming campers live in the nine-county Black Hills area.

Surveys made by the Forest Service and South Dakota Highway Department show that 50 to 60 percent of all out-of-State visitors come from the Midwest and Great Lakes region. Many people pass through the Black Hills on their way to vacation targets farther west or north. About 15 percent make the Hills their vacation destination while 25 percent are headed for other points in South Dakota or Wyoming. Yellowstone National Park, of course, is a favorite target. About 8 percent are bound for California.

In 1965, an estimated 3 million visitors accounted for approximately 11 million "visits" to all recreation areas.

FISH AND WILDLIFE

The nine-county area provides extreme variety in natural environment for fish and wildlife, ranging from high forested hills to open expanses of prairie. Hunting and fishing presently account for more than a half million recreation-days annually in this area.

Fish Habitat and Resources

Reservoirs, lakes, farm and ranch ponds, and beaver dams impound water with a total surface area of 51,500 acres in the nine-county area. Each year, this acreage increases, primarily as a result of farm and ranch pond construction.

The kinds of streams in the area vary considerably—from the larger, turbid, warm-water rivers to clear, cold, trout waters, but a substantial mileage has now lost the quality required for trout. Of the 914 miles of stream of importance as fisheries in the Hills, about 700 miles now provide fishing—the remaining 200 miles is polluted or otherwise unusable.

On the basis of the present conditions of availability, aesthetics, use, and productivity, all streams and impoundments of the Black Hills that are important to fisheries have been classified into five categories:

Class 1 - Waters of nationwide value
Class 2 - Waters of statewide value
Class 3 - Waters of value to large areas less than statewide
Class 4 - Waters of value to small areas such as counties
Class 5 - Waters of strictly local value, polluted or otherwise seriously degraded

Tables 26 and 27, and map 11, show the classification and location of fishing streams and impoundments. Polluted streams having a fishery potential are classified "5".

Cold-water fish in the area include rainbow, brown, and brook trout, in that order of importance. Angostura and Belle Fourche Reservoirs are stocked with warm-water species of walleye, catfish, crappies, bluegills, and bass. Keyhole Reservoir is stocked with rainbow trout in addition to several warm-water species. These reservoirs also contain carp and suckers, as well as numerous species of minnows and other forage fish.

Public agencies currently manage much of the fish habitat in the area. Management of fish resources in most private or federally administered waters is guided by the laws of the States of South Dakota and Wyoming. The direction of management methods and criteria of these resources are probably best explained in current Dingell-Johnson (Federal Aid in Fish Restoration Act) reports published by the two State game and fish departments. The use of trout produced in the National and State fish hatcheries in the area follows policies developed in the "Black Hills Trout Management Policy"—revised and reissued periodically by the South Dakota Department of Game, Fish and Parks and the Bureau of Sport Fisheries and Wildlife. The current policy is based on the following objectives:

1. To manage those waters containing wild fish populations to provide the maximum good quality angling possible on a sustained yield basis.

2. To provide an average angler success of 0.5 hatchery trout per hour in addition to any wild trout. On waters where mean angler success exceeds 1.25 trout per hour, stocking of hatchery trout is curtailed.

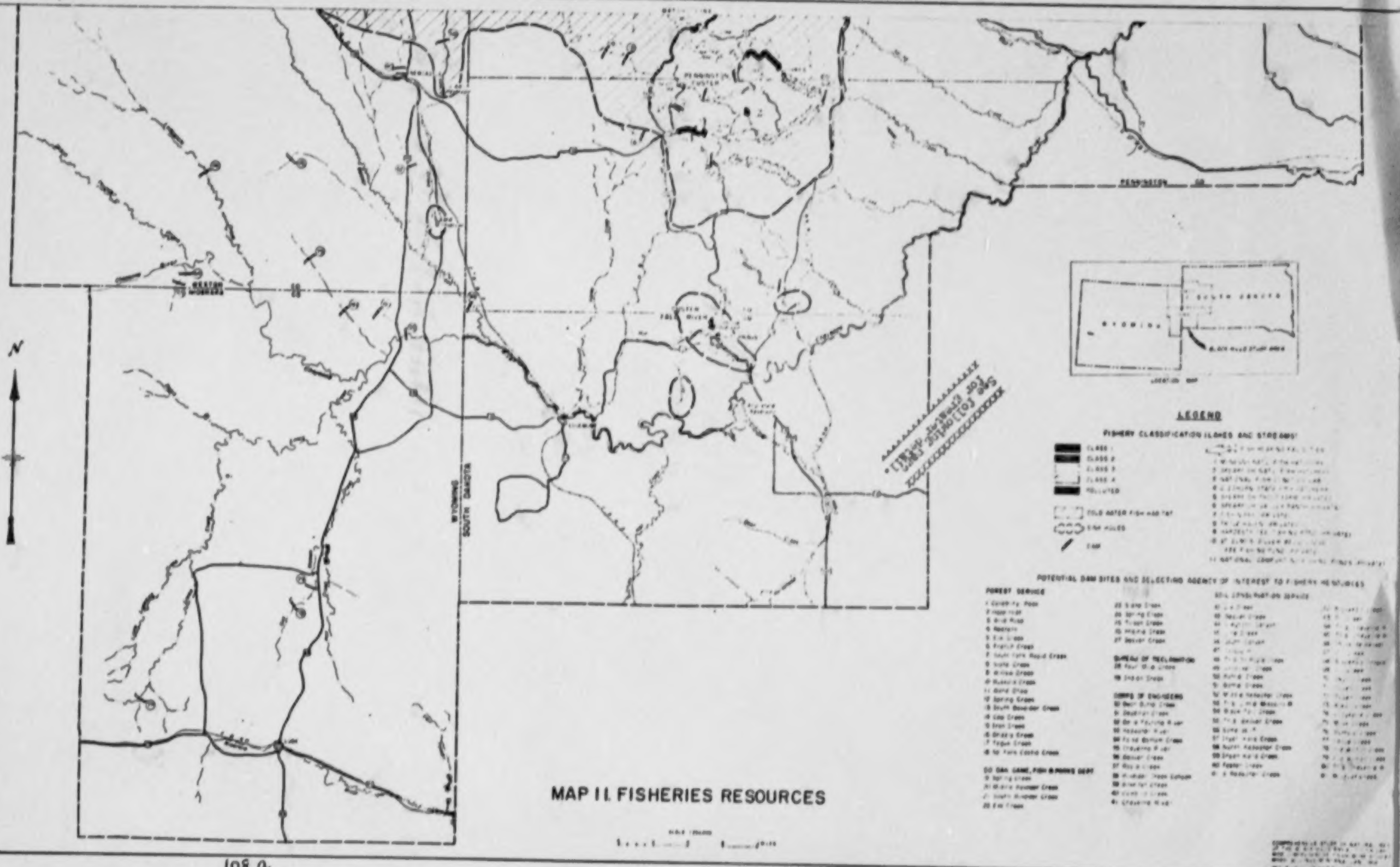
3. To obtain a minimum harvest of 75 percent of the hatchery-reared, catchable-size trout planted in the area.

4. To stock hatchery-reared, catchable-size trout throughout the entire year in suitable water only.

5. To eliminate plants of hatchery trout from waters which are so polluted as to endanger fish life or human health.

Table 26.—Miles of classified fishing streams, nine-county Black Hills area
South Dakota - Wyoming

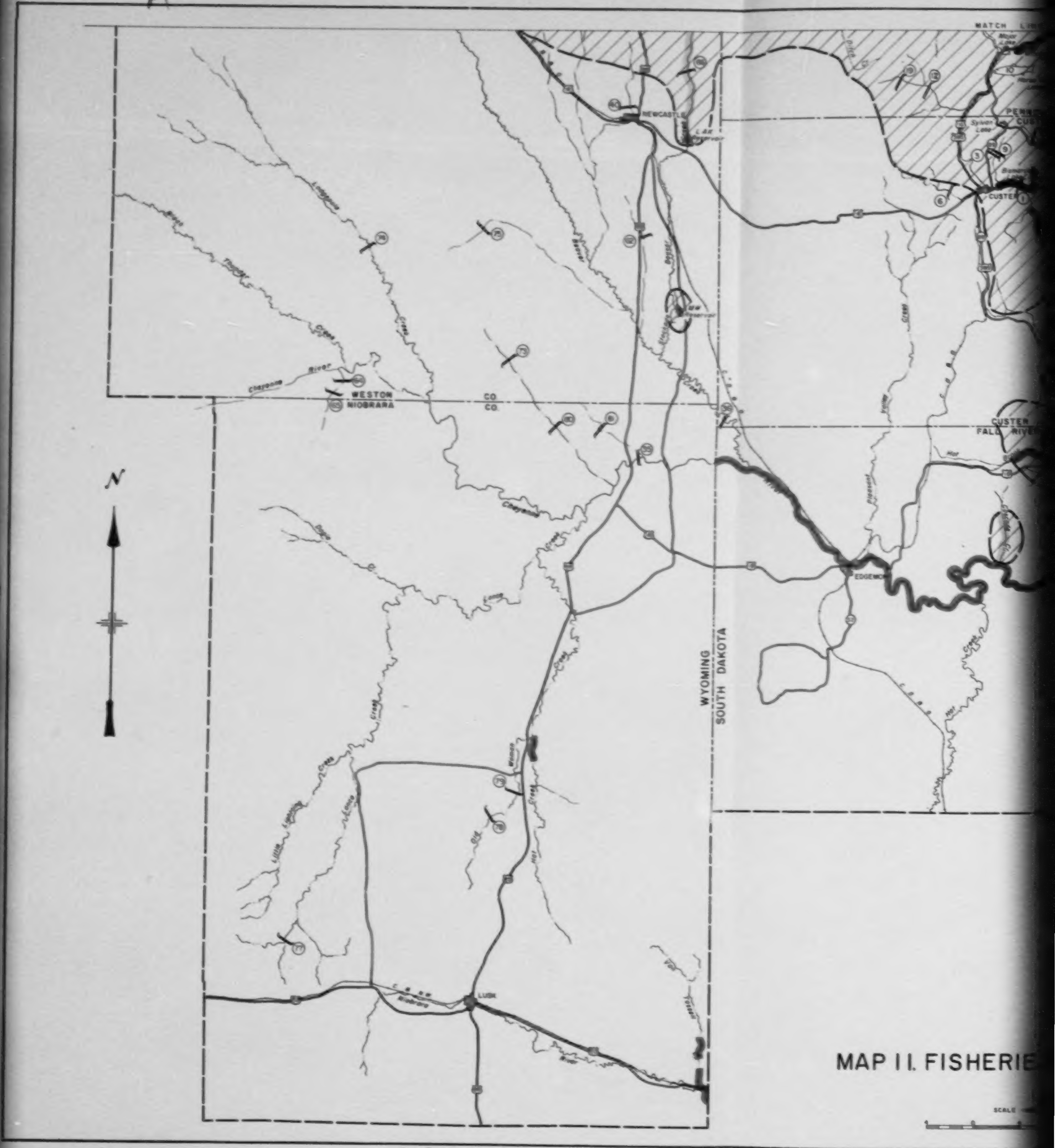
SOUTH DAKOTA	Class One	Two	Three	Four	Five	Limiting factors
Spearfish Cr.	16					Diversions, road work
Little Spearfish Cr.		11				Road work, low flow
Rapid Cr.	25	11		13	40	Low flow, pollution
Castle Cr.	8			15		Low flow, pollution
Middle Fk. Castle Cr.		7				Low flow
South Fk. Castle Cr.		4				Low flow
Redwater R.			20			Siltation
Hanna Cr.		3				Pollution
Crow Cr.			10.5			Small size
S. Fk. Rapid Cr.			8			Siltation
Thompson Ditch			6			Channelization
Cascade Cr.			4			Small size
Rhoads Fk. Cr.			2			Small size
Cheyenne R.				184	20	Low flow, siltation
Belle Fourche R.				70	116	Low flow, siltation
Boxelder Cr.				15		Small size
Spring Cr.				12.5		Small size
Battle Cr.				10.5	6	Small size, pollution
Beaver Cr.				7		Channelization, silt
Iron Cr.				6		Road work siltation
French Cr.				6	2.5	Small size, pollution
Elk Cr.				3.7		Small size
Grace Coolidge Cr.				3.5		Small size
Englewood Cr.				3		Small size
Fall R.				2.5		Small size
Hot Brook				2.5		Small size
Grizzly Cr.				1		Small size
Ditch Creek				1		Small size
Whitewood Cr.					21	Pollution
N. Fk. Castle Cr.					4.5	Pollution
Hop Cr.					2	Siltation
Subtotals	49.0	36.0	50.5	356.2	212	
WYOMING						
Sand Cr.	5.75	4				Periodic flooding
Redwater Cr.		2.5				Low flow, siltation
Stockade Beaver Cr.			11			Spawning sites
Cold Spring Cr.			2.5			Small size
Ogden Cr.			2			Small size
Miller Cr.			1			Small size
Belle Fourche R.				125	25	Siltation, low flow
Little Missouri R.				20		Siltation, low flow
Inyan Kara Cr.				6		Rough fish
Van Tassel Cr.				3		Small size
Hot Cr.				2		Small size
Niobrara R.				1		Small size
Subtotals	5.75	6.5	16.5	157.0	25	
Totals	54.75	42.5	67	513.2	237	



See following page for greater detail

MAP 11. FISHERIES RESOURCES

A



MAP 11. FISHERIE

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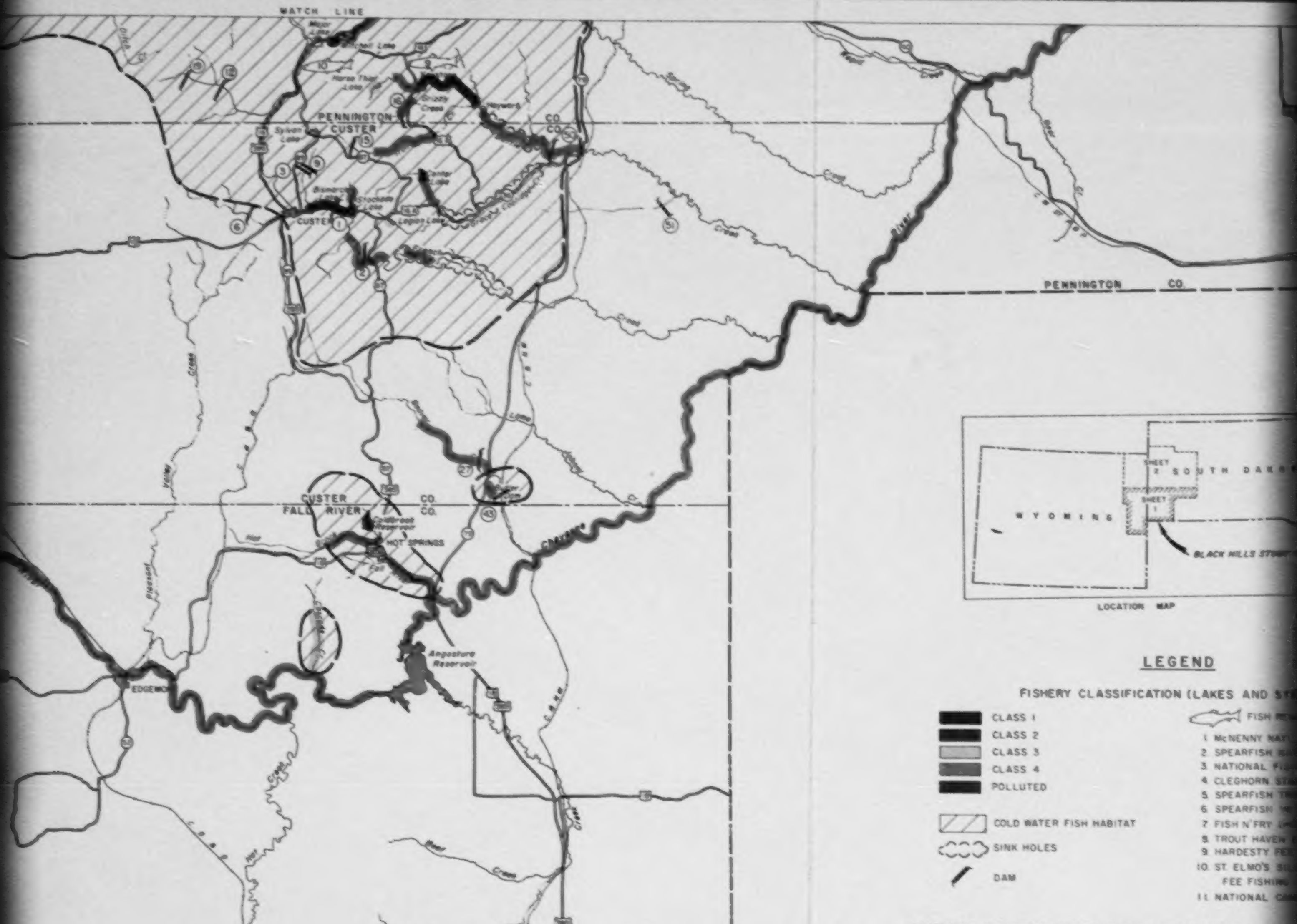


POTENTIAL DAM SITES AND SELECTING AGENCY OF INTERES

FOREST SERVICE

1. Calamity Peak
2. Hazelrodt
3. Wild Rose
4. Redfern
5. Elk Creek
6. French Creek
7. South Fork Rapid Creek
8. Slate Creek
9. Willow Creek
10. Buskala Creek
11. Ward Draw
12. Spring Creek
13. South Boxelder Creek
14. Cow Creek
15. Iron Creek
16. Grizzly Creek
17. Togus Creek
18. So. Fork Castle Creek

SO. DAK. GAME, FISH & PARKS DEPT.

19. Spring Creek
20. Middle Boxelder Creek
21. South Boxelder Creek
22. Elk Creek
23. Slate Creek
24. Spring Creek
25. Tilson Creek
26. Prairie Creek
27. Beaver Creek

BUREAU OF RECLAMATION

28. Four Mile Creek
29. Indian Creek

CORPS OF ENGINEERS

30. Bear Butte Creek
31. Deadman Creek
32. Belle Fourche River
33. Redwater River
34. False Bottom Creek
35. Cheyenne River
36. Beaver Creek
37. Rapid Creek
38. Boxelder Creek Canyon
39. Boxelder Creek
40. Cambria Creek
41. Cheyenne River

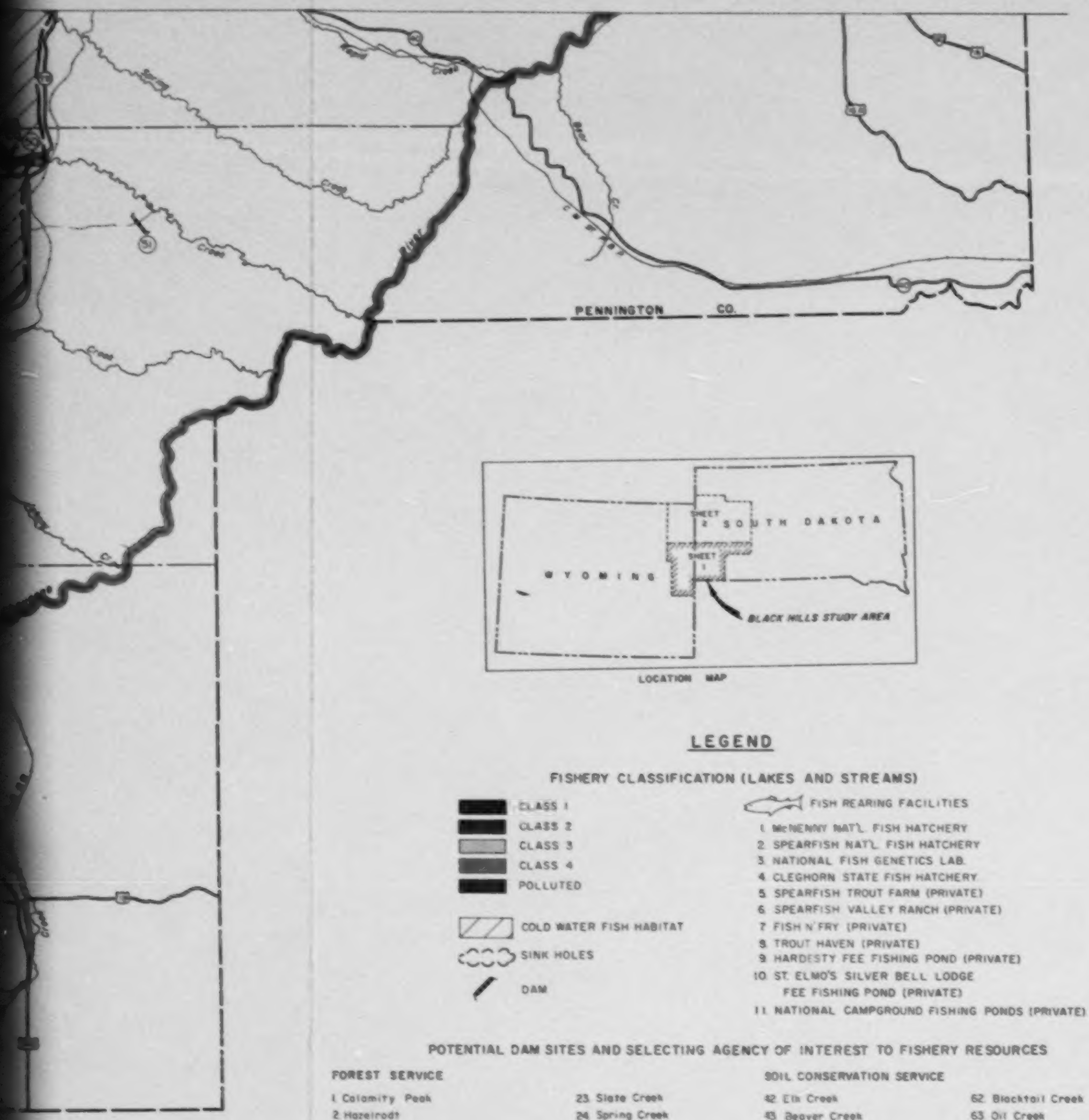
SOIL CONSE

42. Elk Creek
43. Beaver Cre
44. Cleghorn Ca
45. Line Creek
46. South Canyo
47. Cayboy Hill
48. Trib. to Ra
49. Vanocker Cr
50. Battle Creek
51. Battle Creek
52. Middle Redw
53. Trib. Little
54. Black Tail Cr
55. Trib. Beaver
56. Same as 17
57. Inyan Kara Cr
58. North Redwa
59. Inyan Kara
60. Foster Creek
61. S. Redwater

MAP 11. FISHERIES RESOURCES

SCALE 1:250,000

MILES



LOCATION MAP

LEGEND

FISHERY CLASSIFICATION (LAKES AND STREAMS)

■ CLASS 1
■ CLASS 2
■ CLASS 3
■ CLASS 4
■ POLLUTED

▨ COLD WATER FISH HABITAT
SINK HOLES
DAM

FISH REARING FACILITIES

1. McNENNY NAT'L. FISH HATCHERY
2. SPEARFISH NAT'L. FISH HATCHERY
3. NATIONAL FISH GENETICS LAB.
4. CLEGHORN STATE FISH HATCHERY
5. SPEARFISH TROUT FARM (PRIVATE)
6. SPEARFISH VALLEY RANCH (PRIVATE)
7. FISH N' FRY (PRIVATE)
8. TROUT HAVEN (PRIVATE)
9. HARDESTY FEE FISHING POND (PRIVATE)
10. ST. ELMO'S SILVER BELL LODGE FEE FISHING POND (PRIVATE)
11. NATIONAL CAMPGROUND FISHING PONDS (PRIVATE)

POTENTIAL DAM SITES AND SELECTING AGENCY OF INTEREST TO FISHERY RESOURCES

FOREST SERVICE

1. Calamity Peak
2. Hazelrodt
3. Wild Rose
4. Redfern
5. Elk Creek
6. French Creek
7. South Fork Rapid Creek
8. Slate Creek
9. Willow Creek
10. Buskala Creek
11. Ward Draw
12. Spring Creek
13. South Boxelder Creek
14. Cow Creek
15. Iron Creek
16. Grizzly Creek
17. Tague Creek
18. So. Fork Castle Creek

SO. DAK. GAME, FISH & PARKS DEPT.

19. Spring Creek
20. Middle Boxelder Creek
21. South Boxelder Creek
22. Elk Creek
23. Slate Creek
24. Spring Creek
25. Tilson Creek
26. Prairie Creek
27. Beaver Creek

BUREAU OF RECLAMATION

28. Four Mile Creek
29. Indian Creek

CORPS OF ENGINEERS

30. Bear Butte Creek
31. Deadman Creek
32. Belle Fourche River
33. Redwater River
34. False Bottom Creek
35. Cheyenne River
36. Beaver Creek
37. Rapid Creek
38. Boxelder Creek Canyon
39. Boxelder Creek
40. Cambria Creek
41. Cheyenne River

SOIL CONSERVATION SERVICE

42. Elk Creek
43. Beaver Creek
44. Cleghorn Canyon
45. Line Creek
46. South Canyon
47. Cayboy Hill
48. Trib. to Rapid Creek
49. Vanocker Creek
50. Battle Creek
51. Battle Creek
52. Middle Redwater Creek
53. Trib. Little Missouri R.
54. Black Tail Creek
55. Trib. Beaver Creek
56. Same as 17
57. Inyan Kara Creek
58. North Redwater Creek
59. Inyan Kara Creek
60. Foster Creek
61. S. Redwater Creek
62. Blacktail Creek
63. Oil Creek
64. Trib. Cheyenne R.
65. Trib. Cheyenne R.
66. Stockade Beaver
67. Oil Creek
68. Blacktail Canyon
69. Oil Creek
70. Skull Creek
71. Raven Creek
72. Raven Creek
73. Alkali Creek
74. Lodgepole Creek
75. Musk Creek
76. Buffalo Creek
77. Lance Creek
78. Old Woman Creek
79. Old Woman Creek
80. Trib. Cheyenne R.
81. Wildcat Creek

COMPREHENSIVE STUDY OF NATURAL RESOURCES
OF THE BLACK HILLS AREA, SOUTH DAKOTA & WYOMING
MRB COMPREHENSIVE FRAMEWORK STUDIES
MRBS BILLINGS, MONTANA JAN. 1966

MO 4-0-1 SHEET 1 OF 2

6. To reclaim, if possible, headwater streams, small impoundments, and other areas which have been lost to the sport fishery.

There are two national fish hatcheries located in the Black Hills area—the McNenny and Spearfish. They distribute fish to Nebraska and North Dakota as well as locally. For the past five years, their average annual production has been almost 84,000 pounds of fingerlings and catchable-size trout. Other important installations are the National Fish Genetics Laboratory at Beulah, Wyoming, and the Cleghorn State Fish Hatchery near Rapid City, South Dakota. The Cleghorn hatchery produces 55,000 pounds of catchable and fingerling trout annually. It provides at least one half of all trout stocked in the Hills.

Demand for "wild trout" fishing (naturally spawned fish and planted fingerlings) is already far in excess of production capacities of the limited number of high quality streams remaining (photo 7). Paradoxically, warm-water fisheries—of which there is an abundance—seem to attract few people from outside the local area, and fishing activity for warm-water species is well below present capacity.

Table 28 estimates the use made of Black Hills cold-water and warm-water fishery resources. Under current management practices, cold-water use actually exceeds base capacity. This is made possible by "put-and-take" stocking of catchable-size trout (photo 8).

Little use is made of rough fish and there is no commercial fishing in the area. The 424 miles of the Cheyenne, Belle Fourche, and Little Missouri Rivers and the 17,000 acres of Angostura, Belle Fourche and Keyhole Reservoirs could support an annual commercial fish harvest of 300,000 pounds under current management programs.

Seven commercial fish operations in the area have an average annual production of about 14,250 pounds of trout, 300 pounds of bass, and 500 pounds of bullheads. Most of these fish are used by local fee-fishing businesses for tourists.

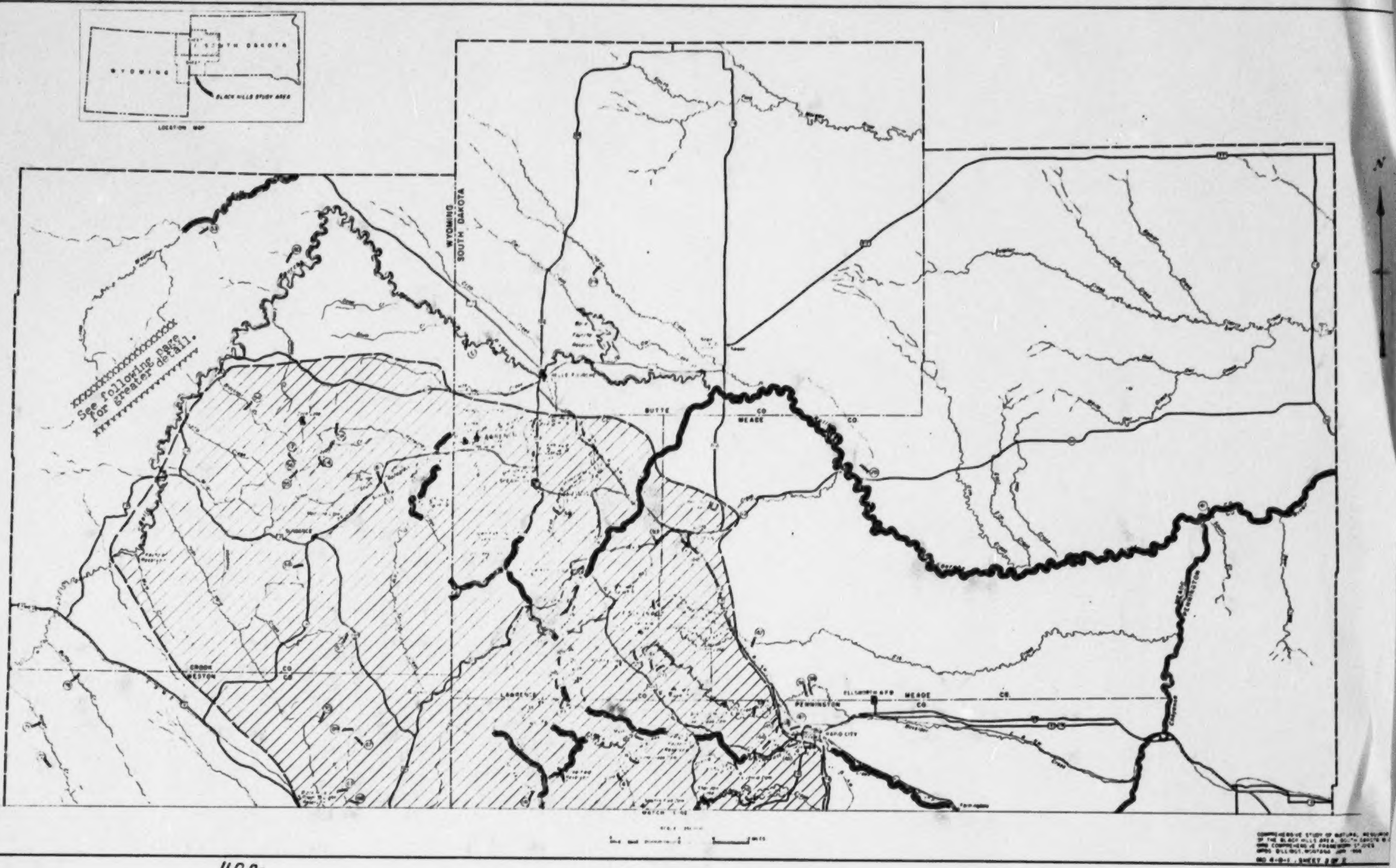
The trend is one of increasing demand on a steadily decreasing resource now supported by intensive put-and-take stocking that becomes more costly and tends to cause declining satisfaction.

Wildlife Habitat and Resources

Three broad types of wildlife habitat are found in the nine-county area: pasture and rangeland, forest and woodland, and arable and irrigated land. Most of the forested areas are in the higher elevations and in large blocks of Federal ownership interspersed with small private holdings, usually in the valley bottom lands. In contrast, most of the open pasture-rangeland and irrigated cropland is privately owned and in the plains portion; however, scattered throughout are lands administered by Federal and State agencies.

Table 27.—Acres of classified fishing impoundments, nine-county Black Hills area
South Dakota - Wyoming

			Class			
SOUTH DAKOTA	One	Two	Three	Four	Five	Limiting factors
Deerfield Res.	435					Siltation
Sheridan Lake	395					Siltation
Center Lake	25					Small size
Cold Brook Dam		40				Small size
Mirror Lake		9				Small size
Coxes Lake		4				Small size
Pactola Res.			800			Pollution
Iron Cr. Lake			23			Small size
Horse Thief Lake			20			Small size
Sylvan Lake			17			Small size
Roubaix Lake			9			Small size
Legion Lake			8			Small size
Major Lake			5			Small size
Victoria Dam			5			Small size
Slate Cr. Dam.			4			Small size
Dalton Lake			2			Small size
Newton Fk. Dam			1.5			Small size
Angostura Res.				5,000		Turbidity, fluctuation
Belle Fourche Res.				5,000		Turbidity, fluctuation
Bear Butte Lake				150		Small size
Bismarck Lake				22		Small size
Newell City Pond				20		Small size
Homestake Pond				15		Siltation, size
Butler Dam				10		Small size
Reausaw Lake				4		Siltation, size
Deer Cr. Dam				1		Small size
Stockade Lake					128	Small size, pollution
Canyon Lake					37	Pollution, siltation
Mitchell Lake					8	Small size, pollution
Beaver ponds		(No acreage figure)				Small size
Farm-ranch ponds		(31,800 acres unclassified)				Small size
Subtotals	855	53	894.5	10,222	173	
WYOMING						
Keyhole Res.			7,000			Turbidity, fluctuation
LAK Res.				110		Small size
MW Res.				100		Small size
Cook Lake				31		Small size
B.H.P.& L. Res.				25		Small size
Medicine Lake				22		Small size
Sundance Pond				6		Small size
Beaver ponds					10.5	Small size
Farm-ranch ponds					284.7	Small size
Subtotals			7,000	294	295.2	
Totals	855	53	7,894.5	10,516	468.2	
Grand Total						51,588 acres



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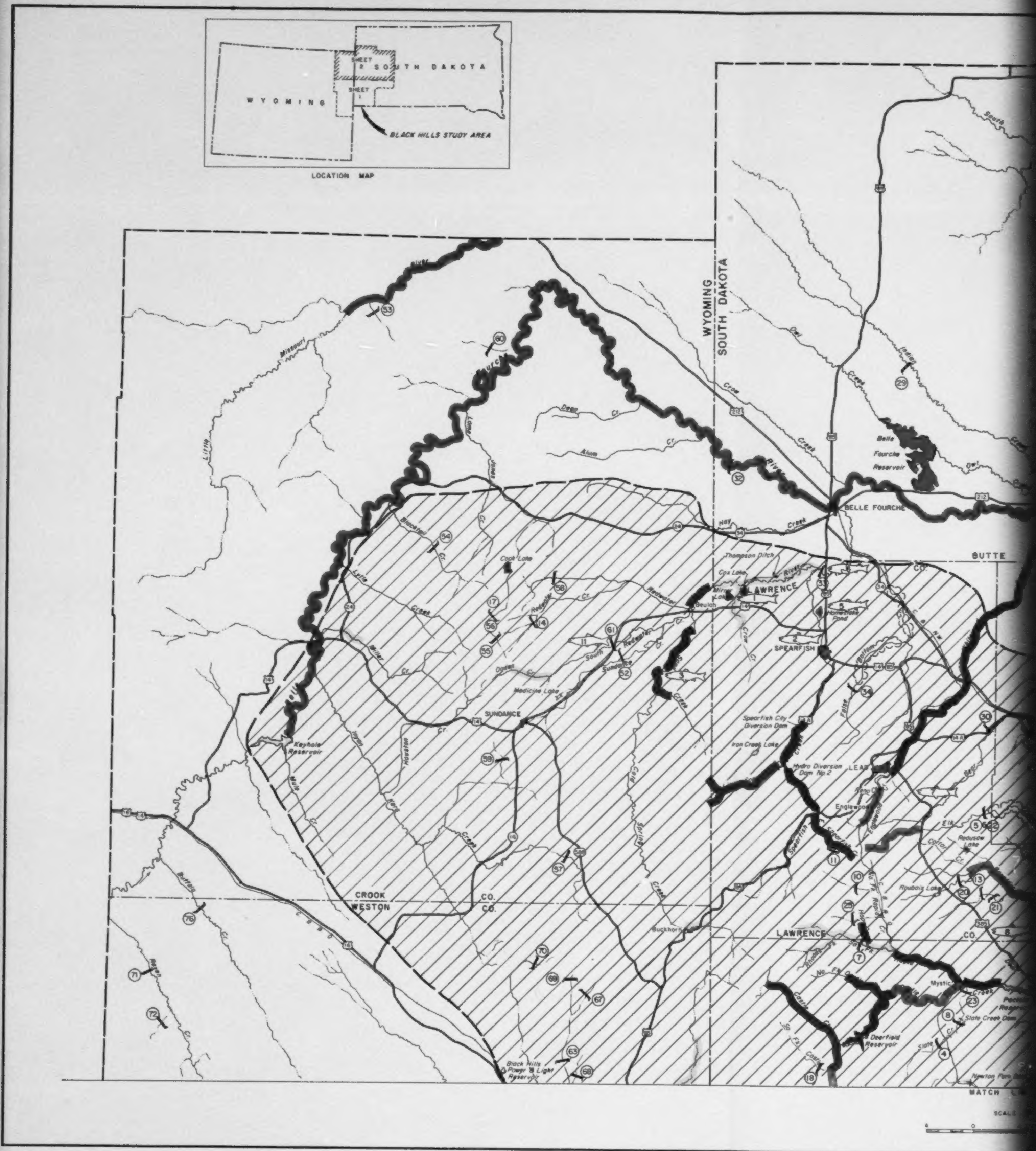

WYOMING
SOUTH DAKOTA
SHEET 2
SHEET 1
BLACK HILLS STUDY AREA
LOCATION MAP
WYOMING
SOUTH DAKOTA
Little Missouri River
Belle Fourche River
Deep Cr.
Alum Cr.
Crow Creek
Owl Creek
Indian
Belle Fourche Reservoir
BELLE FOURCHE
Hay Creek
Thompson Ditch
Cox Lake
Mirror Lake
LAWRENCE
BUTTE CO.
Redwater River
Beulah
Homestake Pond
SPEARFISH
Crow Cr.
False Bottom
Blacktail Cr.
Cook Lake
Lytle Creek
Miller Cr.
Redwater Cr.
South Redwater
Sundance
Ogden Cr.
Medicine Lake
SUNDANCE
Sand Creek
Cold Springs Creek
Keyhole Reservoir
Houston Cr.
Hay Creek
Spearfish City Diversion Dam
Iron Creek Lake
Hydro Diversion Dam No. 2
LEAD
Englewood
Elk
Redstaw Lake
Roubaix Lake
Spearfish Creek
CROOK CO.
WESTON CO.
Buffalo Cr.
Beaver Cr.
Buckhorn
LAWRENCE CO.
Mystic
Deerfield Reservoir
Slate Creek Dam
Slate Cr.
Castle Creek
Black Hills Power & Light Reservoir
Newton Fork
MATCH LI
SCALE
53
60
32
29
54
58
17
56
55
14
61
52
3
2
5
1
34
30
59
57
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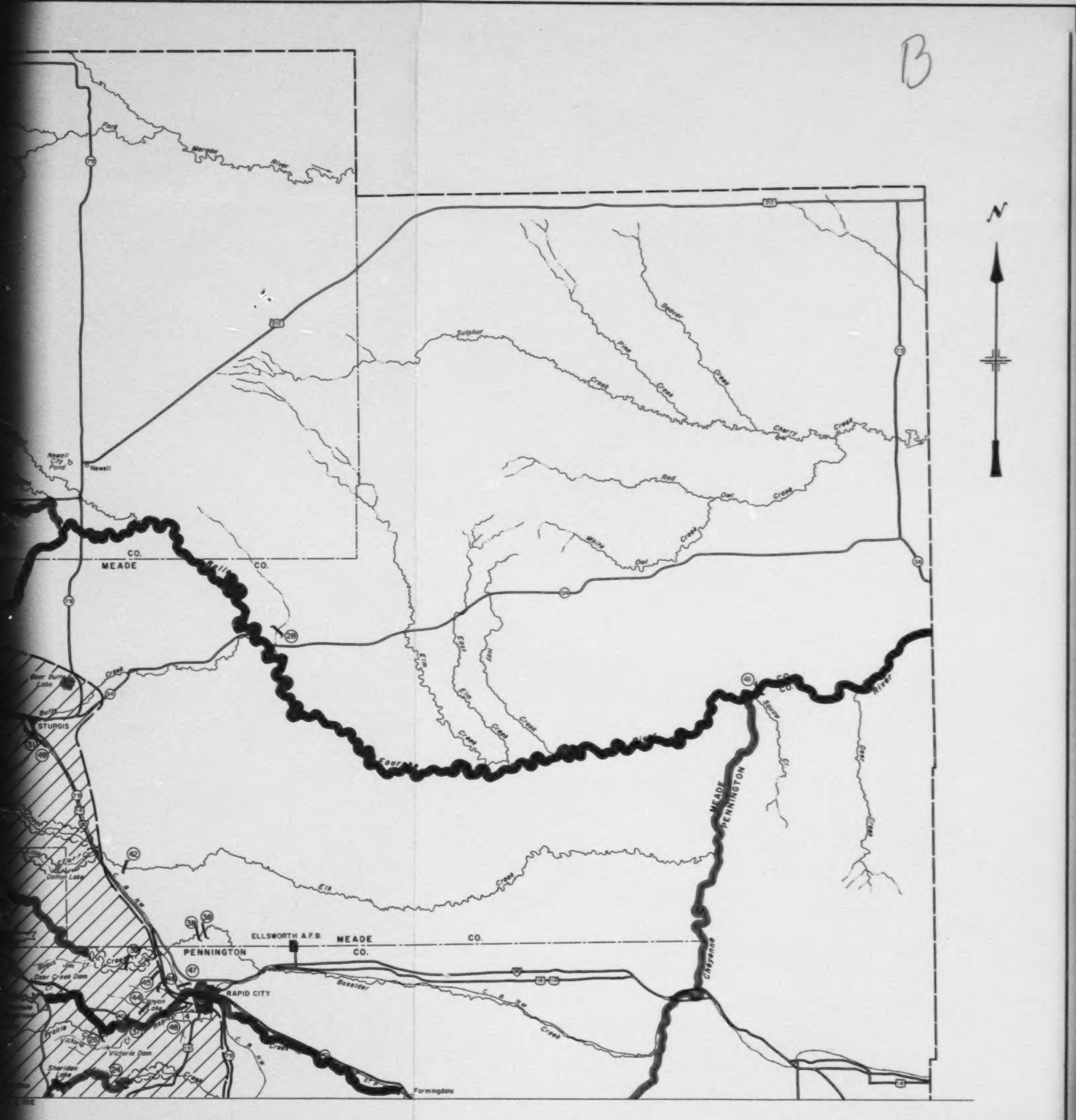


COMPREHENSIVE STUDY OF NATURAL RESOURSES
OF THE BLACK HILLS AREA, SOUTH DAKOTA & WYOMING
MRB COMPREHENSIVE FRAMEWORK STUDIES
MRBS BILLINGS, MONTANA JAN. 1966

MO 4-0-1 SHEET 2 OF 2

Photo 7. Trout is the mainstay of Black Hills fishing. Cold-water streams, often enhanced by beaver dams, provide the idyllic setting and quality fishing that attracts many visitors.

Photo 8. Reservoir fishing can provide a strong base fishing capacity. Cold-water reservoirs, such as Deerfield, can go a long way toward providing the base capacity to satisfy future cold-water fishing demands.

Table 28.—Use and capacity of fisheries, 1965

Fishery resources [a]	Classes	Fishermen-days use	Fishermen-days capacity [b]
Cold-water	1,2,3,& 4	248,000	175,000
Warm-water	3,4,& 5	78,000	140,000
		326,000	315,000 [c]

[a] Streams and lakes.

[b] With continued stocking of catchable trout and introduction of other desirable warm-water species like small-mouth bass, walleye, sauger, and catfish into suitable habitat.

[c] Capacity could be increased to about 1 million fishermen-days with very intensive put-and-take stocking.

As can be seen on maps 12 and 13, deer prefer the timbered mountains (photo 9) and areas along the Cheyenne and Belle Fourche Rivers while antelope prefer the pasture and rangeland plains areas.

Most upland game birds prefer the nontimbered habitat of the area. Turkey is a notable exception (map 14). Fur-bearing animals (mink, beaver, muskrat, etc.) are associated primarily with the Cheyenne and Belle Fourche Rivers and their tributaries. Based upon the amount of hunting provided, the quality and quantity of wildlife habitat have been classified (table 29).

Table 29.—Wildlife habitat classification

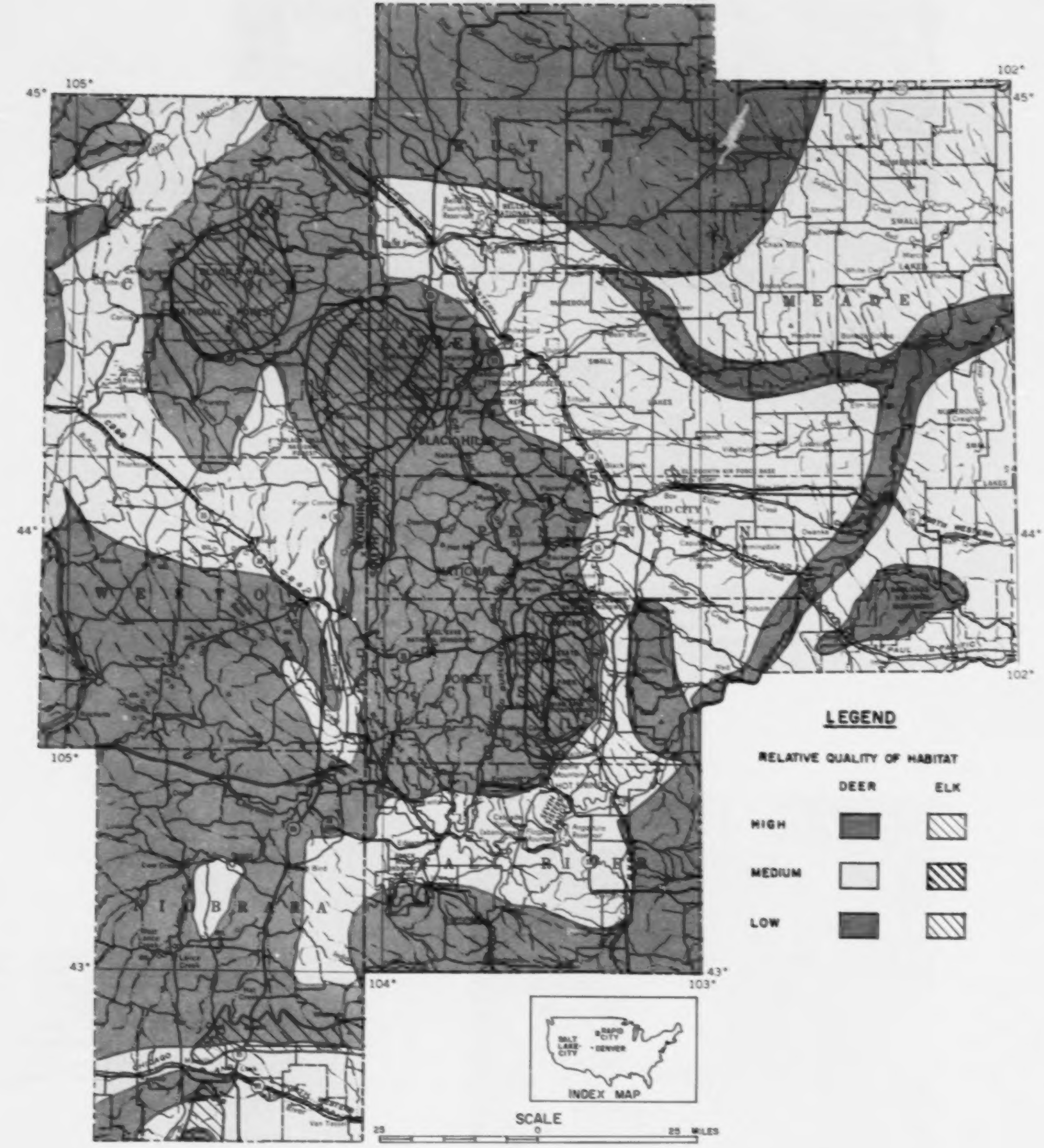
Species or group	Habitat in square miles - value								
	High	Percent	Medium	Percent	Low	Percent	Unoccupied	Percent	Total
Deer	7,155	35	8,295	40	5,065	25	0	0	20,515
Elk	110	1	0	0	1,260	6	19,145	93	20,515
Antelope	10,105	49	2,050	10	4,135	20	4,225	21	20,515
Upland game [a]	2,740	13	9,790	48	7,985	39	0	0	20,515
Other [b]	4,700	23	2,015	10	13,800	67	0	0	20,515
Fur animals [c]	1,032	5	1,092	5	607	3	17,784	87	20,515

[a] Includes turkey, pheasant, sharp-tailed grouse, Hungarian partridge, and sage grouse.

[b] Includes coyote, fox, bobcat, and raccoon.

[c] Includes beaver, mink, and muskrat.

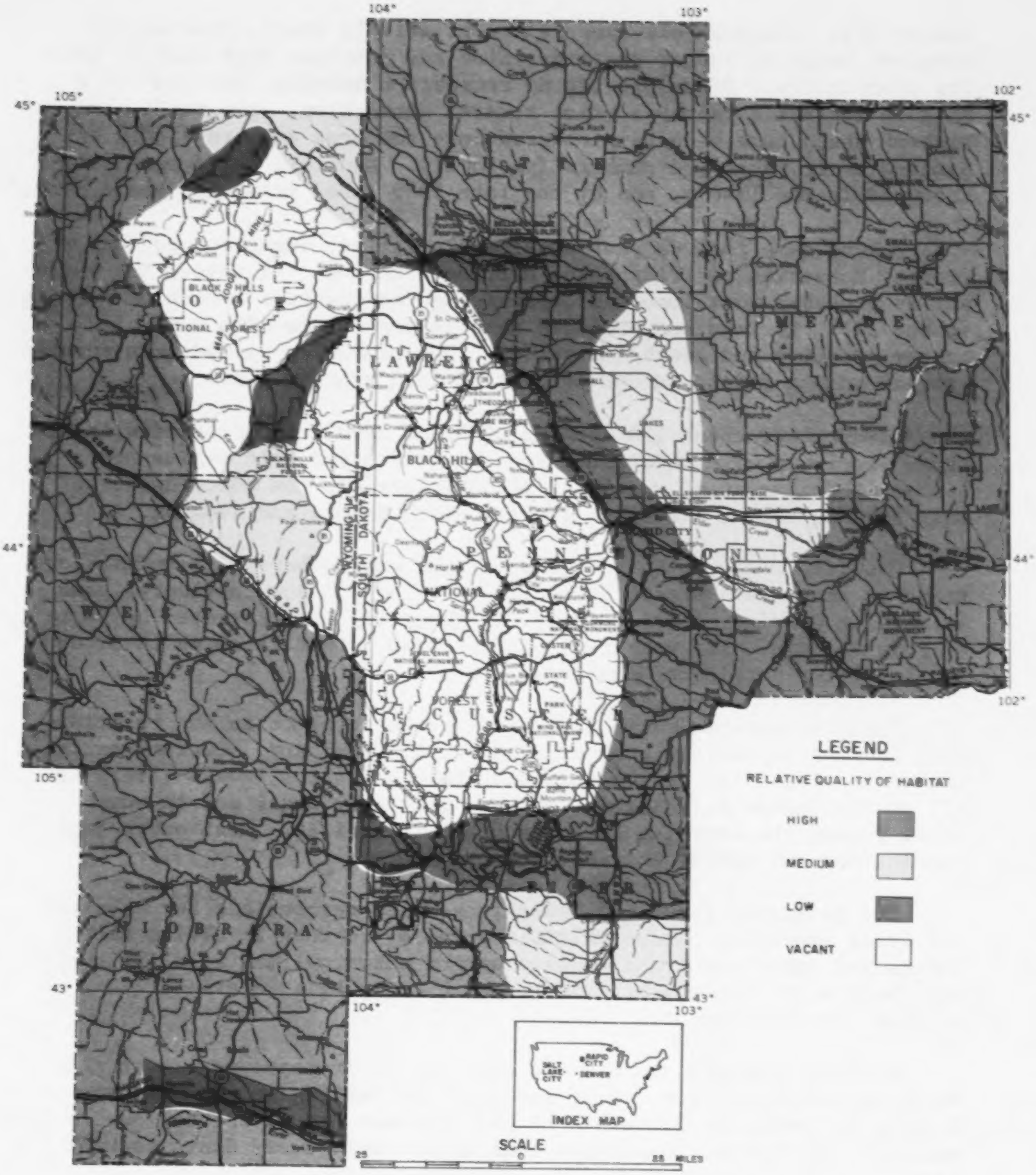
The big game include white-tailed deer and mule deer, antelope, elk, bighorn sheep, mountain goats, and bison. Deer and antelope are found in large numbers and provide the bulk of big game hunting



MAP 12. DEER AND ELK HABITAT

Photo 9. A winter mule deer concentration in Spearfish Canyon, northern Black Hills. Concentrations such as this can badly abuse available browse. Heavy populations in restricted areas require habitat management of a high order to perpetuate quality hunting in the Hills.

Photo 10. Deer provide the hunting base for the Black Hills. In 1965, over half of the hunting activity was devoted to the pursuit of deer. Maintaining quality hunting and hunter satisfaction as exemplified in this photo should be the principal objective of future management.



MAP 13. PRONGHORN (ANTELOPE) HABITAT

(photo 10). Although elk numbers are relatively small, this animal measures large in hunter prestige value and provides high quality hunting opportunity. Bison provide no recreation hunting, but rank very high in aesthetic value—a prime tourist attraction. Two small herds of bighorn sheep have been reintroduced into the area and are slowly expanding their range and numbers (photo 11). Mountain goats were reintroduced in the 1920's, and by the late 1940's had saturated their range.

Upland game include pheasants; sharp-tailed, sage, and ruffed grouse; Hungarian partridge; and Merriam's turkey. Of these, the pheasant is probably most important, providing the greatest amount of hunting (photo 12). Turkeys are probably next in importance with very high hunter prestige and aesthetic values. The remaining upland-game species provide only a modest amount of hunting from year to year.

Altogether, about 220 species of birds have been identified in the area. Included with this group are the golden and bald eagles now listed as "endangered" species. Also included is the mourning dove; this bird is on the protected list in South Dakota and Wyoming.

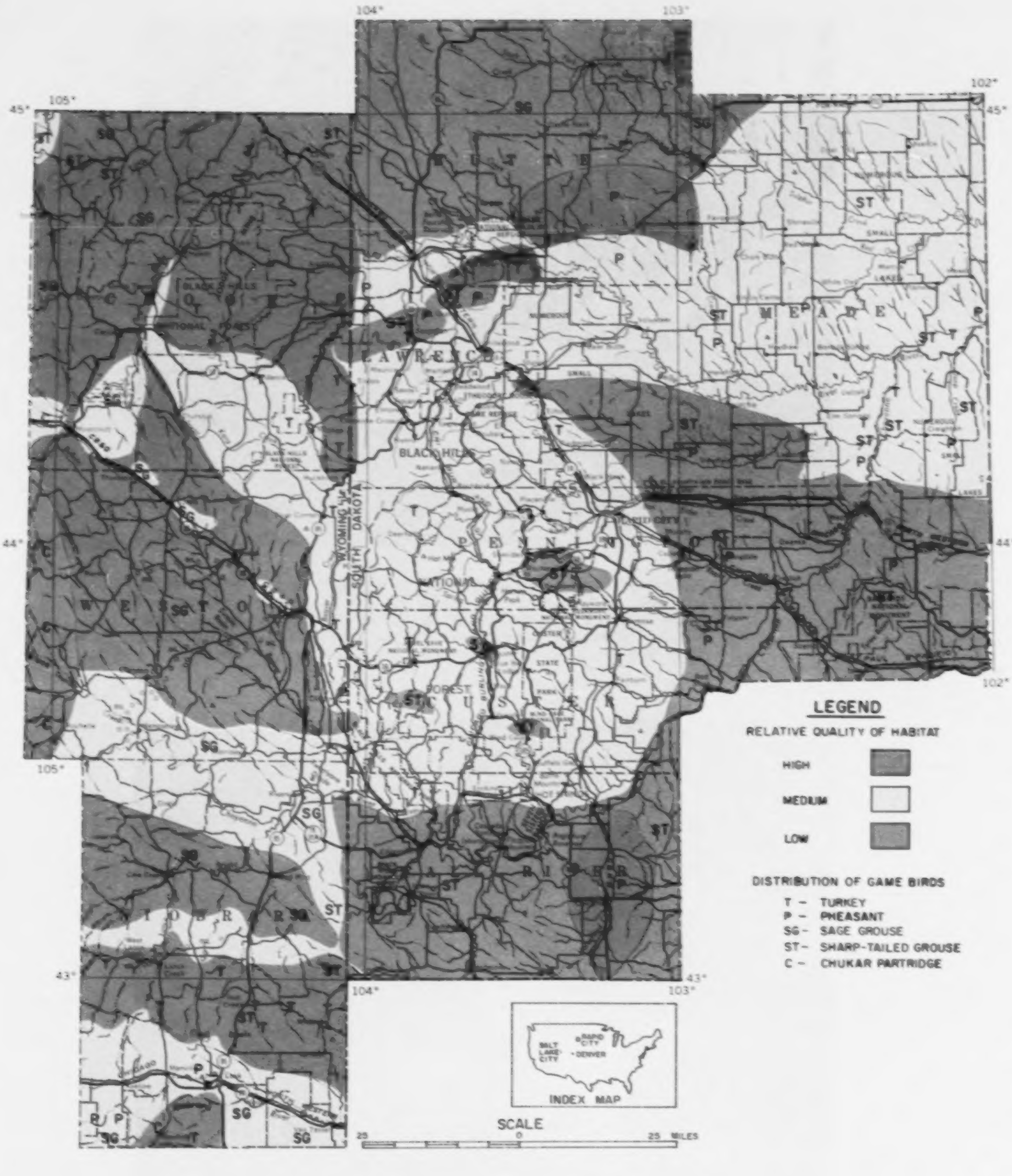
Rabbits, foxes, bobcats, coyotes, and many other small animals are found in the area. Except for cottontails, which are considered game animals in Wyoming, these animals are generally not protected by State or Federal laws. The very rare black-footed ferret is known to occur in the plains portion of the area.

There is extreme variability from place to place in the relationship between population and habitat-carrying capacity. Current management data of the two States indicate that population levels (1965) of all of the hoofed wildlife in the area generally equal and in some areas exceed the carrying capacity of their habitat. Most other game populations can safely increase to some degree.

The principal State and Federal agencies responsible for wildlife resources generally pursue multiple-purpose programs involving such things as: improvement and development of waterfowl and wildlife habitat, population management, and research and public relations (including law enforcement).

Hunting pressure and use are expected to increase on almost all hunted wildlife species. Deer and antelope hunting in northeastern Wyoming is among the finest to be had anywhere and is unquestionably of national importance. Sportsmen come from almost every State to hunt here.

Intensive management has established populations of the bighorn sheep and mountain goat in suitable habitat. Since only a minor portion of the Wyoming Black Hills area is in public ownership, posting of private lands can restrict hunting opportunities, especially big-game hunting. Also, Wyoming law prohibits nonresident hunting on national forest



MAP 14. UPLAND GAME BIRD HABITAT

Photo 11. Audubon's bighorn sheep became extinct in the Black Hills in 1924. Reintroduction of the Rocky Mountain bighorn has established a small number of sheep in Custer State Park. While these animals provide no hunting at the present time, they are an outstanding wildlife attraction to the visitor.

Photo 12. The pheasant is the mainstay of upland bird hunting in the nine-county area. Obvious satisfaction of a successful hunter is the reward of proper management.

Photo 11. Audubon's bighorn sheep became extinct in the Black Hills in 1924. Reintroduction of the Rocky Mountain bighorn has established a small number of sheep in Custer State Park. While these animals provide no hunting at the present time, they are an outstanding wildlife attraction to the visitor.

Photo 12. The pheasant is the mainstay of upland bird hunting in the nine-county area. Obvious satisfaction of a successful hunter is the reward of proper management.

lands unless the hunter is accompanied by a licensed guide or a resident hunter. This, of course, tends to restrict big-game hunting.

The trend is expected to be one of increasing demand for hunting opportunities on a resource which is not expected to increase greatly in quantity under current habitat management practices (table 30).

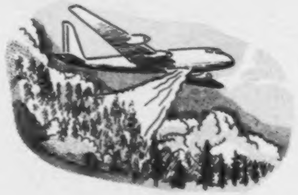
Waterfowl Habitat and Resources

Although the entire area is important to waterfowl migrants in both spring and fall, for the most part, local habitat is associated primarily with only the prairie portion. Its quality is rated low for geese and from low to medium for ducks. Nevertheless, 10,000 to 20,000 mallards winter each year in the northern Black Hills. Most of these birds arrive too late in the season to provide as much shooting as their numbers might suggest. There are more than 11,000 man-made stock water ponds and erosion control structures in the nine counties, most of which can provide suitable waterfowl habitat.

Nearly all species of waterfowl found in the Central Flyway are present in the area at some time of the year, but numbers are relatively small when compared to the overall flight. Breeding populations are composed mostly of mallard and blue-winged teal. Nesting geese are represented in relatively small numbers by the Canada group.

One waterfowl wildlife refuge is maintained in the area, Bear Butte National Wildlife Refuge. It is situated in Meade County, South Dakota, and is managed by the Bureau of Sport Fisheries and Wildlife. The Belle Fourche National Wildlife Refuge was abolished in 1964.

Waterfowl provide an estimated 12,000 man-days of hunting annually (table 31). Factors limiting current use include poor access to hunting areas, certain restrictions by recent Federal regulations, and hunting prohibitions for nonresidents in South Dakota. With improvement, however, local habitat can support substantially more hunting.



MANAGEMENT AIDS

In this report the term "Management Aids" is used to designate those activities which directly affect management of more than one natural resource. Such things as fire protection, access, roadside control, and zoning are considered.

Table 30.—Hunting use and capacity (man-days per year)

Resource	Wyoming 1965		South Dakota 1965		Total 1965		1965-1980	2000
	Use	Capacity	Use	Capacity	Use	Capacity	Capacity	Capacity
Deer 1/	43,400	43,400	75,000	85,000	118,400	128,400	152,500	152,500
Antelope	9,200	9,200	10,500	12,000	19,700	21,200	23,500	23,500
Elk	2,200	2,200	400	400	2,600	2,600	4,800	4,800
Bighorn sheep	0	0	0	0	0	0	50	50
Mountain goat	0	0	0	100	100	100	100	100
Bison	0	0	0	0	0	0	0	0
Merriam's turkey	6,000	6,000	8,400	12,000	14,400	18,000	23,000	23,000
Pheasant	0	0	18,000	18,000	18,000	18,000	18,000	18,000
Sharp-tailed grouse	0	0	4,900	6,000	4,900	6,000	6,000	6,000
Ruffed grouse	0	0	200	400	200	400	400	400
Sage grouse	150	150	200	500	350	650	750	750
Hungarian partridge	0	0	300	300	300	300	300	300
Rabbit 2/	3,300	3,300	10,000	20,000	13,300	23,300	26,600	30,000
Other 3/	3,650	3,650	11,000	11,000	14,650	14,650	14,650	14,650
Total	67,900	67,900	138,900	165,700	206,900	233,600	270,650	274,050

1/ Includes both mule deer and white-tailed deer.
2/ Includes jackrabbits, cottontail, and snowshoe hare.
3/ Includes fox, coyote, raccoon, bobcat, prairie dog, and woodchuck.

Table 31.—Summary of use and capacities of wildlife

Resources	Man-days	
	Use	Capacities
Big game	140,800	152,300
Small game	51,450	66,650
Other	14,650	14,650
Waterfowl	12,000	*
Total	218,900	233,600

* Capacity not estimated.

Wildfire Protection

Many natural resource values can be destroyed by wildfire. Timber, range, and recreation values; fish and wildlife habitat; water purity and improvements are destroyed all too often. Fire control, therefore, is a pressing, important management problem.

It is much cheaper to prevent fires than to fight them. The Forest Service and State foresters, in cooperation with private industry and other State and Federal agencies, conduct a very intensive fire prevention campaign each year. During 1965, many agencies and individuals cooperating in the "Smokey Bear" campaign, in an effort to reduce the unnecessary waste that occurs each year, made almost 100,000 contacts with the public to inform them of the hazards that exist with forest and range fires.

An especially valuable tool in the prevention of wildfire is employed by the State of South Dakota through its Law No. 20.0504, "the Burning Permit law." The law requires that a burning permit be obtained for each open fire within the Black Hills Protection District.

Like the Prevention phase, the "Presuppression" (preparedness) phase of wildfire protection in the area is built around efforts of the Forest Service. It is on the national forest and the national grasslands that the largest and most disastrous losses from wildfire can occur. The Forest Service has responsibilities for protecting over 1.5 million acres within the nine-county area from fire.

Presuppression activities include fire detection from nine manned lookout towers and intensive use of aerial observation whenever conditions warrant. Equipment includes more than 45 truck tankers varying in capacity from 50 to 1,000 gallons.

The most spectacular firefighting tools used are airplanes, especially the aerial tanker. These tankers have a capacity of 2,000 gallons of fire retardant and usually operate from bases at Spearfish, Newcastle or Casper, with secondary bases at Rapid City and Hot Springs. Aerial tankers are used to cool down and slow down the hot and fast-moving fronts of grass or timber fires by dousing them with slurry mixtures of bentonite or other fire retardants mixed with water. The fires then can be more easily controlled by ground crews.

Skilled firefighters are available from the State and Federal land management agencies and from local rural fire departments. They number almost 200. In addition, nearly 1,500 skilled men are available for firefighting during extreme fire danger periods from the various military bases, the Pine Ridge and Rosebud Sioux Indian Reservations and the Homestake Mining Company. The latter two maintain a hard core of highly trained leaders for this manpower. Handtools for these firefighters are located in fire caches scattered strategically throughout the area.

Communications for fire presuppression and suppression activities, including the dispatching of manpower and equipment to fires, are carried over several Federal and State radio network systems.

The Forest Service maintains its first line of fire defense at the ranger district level. Backup assistance is available at forest supervisors' offices in Custer, South Dakota, and Laramie, Wyoming. In addition, an almost unlimited amount of equipment and manpower may be obtained through the Forest Service regional fire dispatcher in Denver, Colorado.

The National Park Service conducts fire protection activities within each of its five areas. It maintains handtools, fire tankers, and trained manpower in each area.

With assistance from the Forest Service under Section 2 of the Clarke-McNary Act (June 7, 1924 - 43 Stat. 653), the State foresters of Wyoming and South Dakota administer fire protection and control programs for State and private lands. Local fire departments in the Black Hills have been provided technical and financial assistance and more than 200 firefighting vehicles. The South Dakota State forester is charged with responsibility for fire protection on State and private lands inside the boundary of the Black Hills Fire Protection District.

Cooperative firefighting agreements involving mutual aid or reimbursement of suppression costs are often the best means of coping with the complex fire control problems in the area. Examples are: land administered by the Bureau of Land Management around Deadwood and Lead is protected from fire under contract by the Forest Service; and around the State of Wyoming's Keyhole Reservoir, about 6,700 acres are protected under contract by the Crook County Fire Protection District.

Access to Public Lands

In the central portion of the nine-county area the Federal and State governments administer large blocks of land. Main access routes now provide a good network of highways, but many are too narrow for the heavy July and August tourist traffic. Secondary roads do not provide complete coverage, and several of the more important lack adequate surfacing.

On the plains, concentrations of public land are smaller and more scattered. Lands administered by the Bureau of Land Management, for example, are scattered throughout the nine-county area. Almost all of the tracts are interspersed with private lands. All public lands managed by the Bureau of Land Management and the Forest Service are open to the public. In too many instances, however, access to these public lands is blocked by privately owned lands. In other cases, roads may be entirely lacking or in almost unusable condition.

All lands within the nine-county area are open for both fire protection and insect and disease control activities. Hunting and fishing activities, on the other hand, are frequently restricted. In some areas, owners of property adjoining Federal lands post no-trespassing signs that deny access to all but personal friends. In much of Butte County (and portions of adjoining Harding County and into Montana), most private lands have been closed to public hunting.

Other Management Aids (Including Zoning, Planning and Roadside Controls)

Coordinated zoning and land-use planning are essential to proper development and integration of our natural resources and communities. Recent legislation has provided counties in both South Dakota and Wyoming with limited zoning authority but no active, coordinated regional program has developed. Zoning on national forest land is accomplished through the Secretary of Agriculture's regulations. These regulations provide for proper use of the land through observance of comprehensive management guides and through issuance of Special Use Permits. Similarly, regulations have been developed for lands administered by other Federal agencies.

Public laws enacted during the first session of the 88th Congress did much to increase the Bureau of Land Management's opportunities in meeting land-use planning and zoning needs. Under the temporary authority for the sale of certain public lands (P.L. 88-608), lands required for the orderly growth and development of communities, or which are chiefly valuable for such uses as residential, commercial, or industrial, can be sold after zoning regulations have been enacted by the appropriate local authority.

Both South Dakota and Wyoming have county recreation board or commission enabling acts. The Wyoming Parks Commission works jointly with the National Park Service, Bureau of Reclamation, and Tri-County Recreation Planning Board on setting up priorities of use and analyzing recreation demand around Keyhole Reservoir.

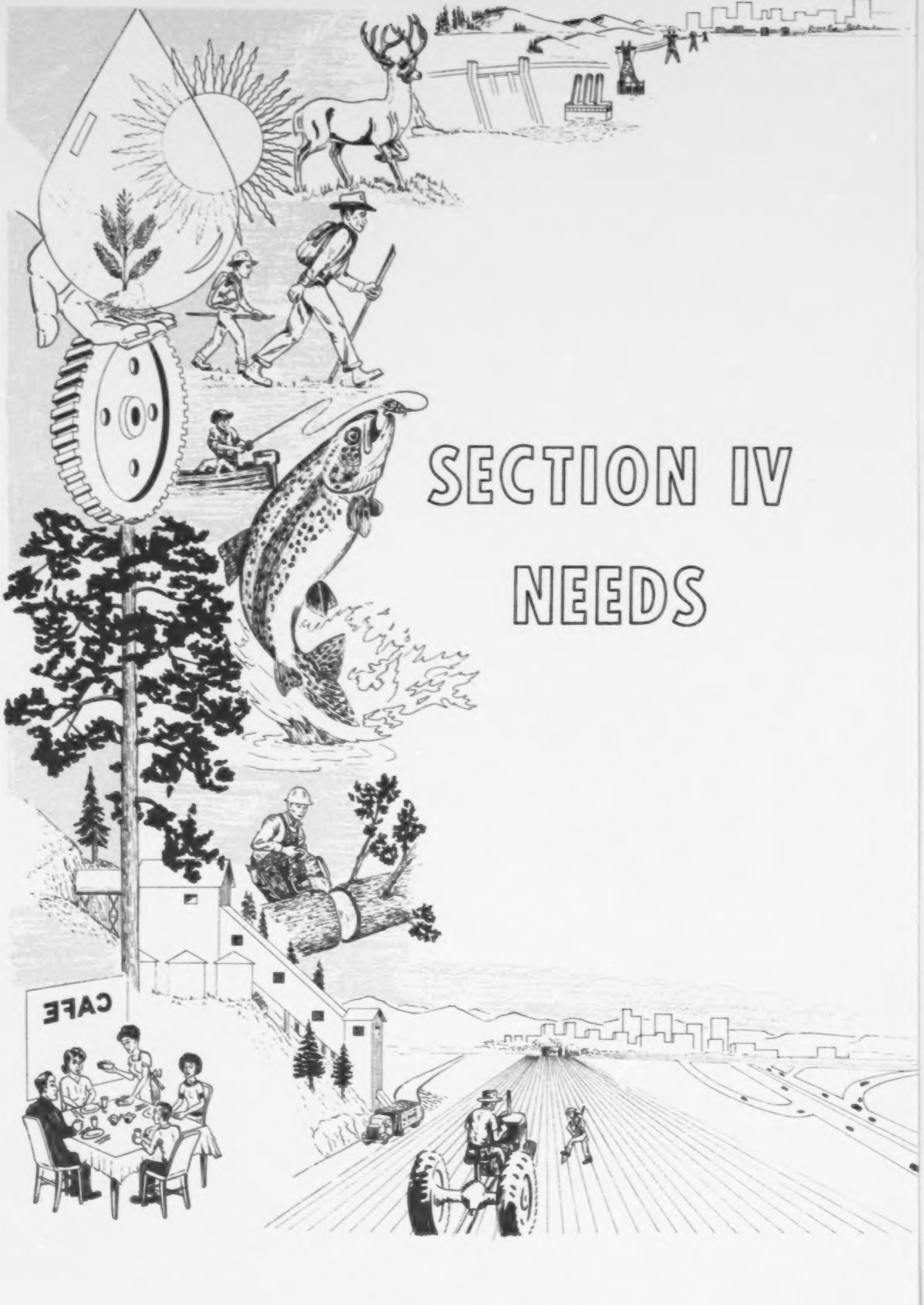
Interstate 90 is relatively free from inappropriate signs, billboards, and auto "graveyards"; unfortunately, however, too many other roadside scenes are marred by unsightly rubbish dumps, too many or too garish advertising signs, utility lines, and shabby tourist developments. In some areas, billboards are especially detrimental to the natural beauty.

Constant change in land use is taking place. Cities and towns are expanding and looking for more room. Cropland becomes eroded and is shifted to grazing or other use. These and similar changes are at work in the Black Hills area. Most agencies managing public lands have been given authority providing for adjustments in land use and exchange of ownership or administration. The scattered, isolated tracts of public lands managed by the Bureau of Land Management are continually being

Photo 13. Unlike Interstate 90, this roadside scene in the Black Hills is marred by billboards and advertising signs.

Photo 14. A typical example of an unsightly and unscreened "auto graveyard."

reviewed for land adjustment possibilities. Isolated tracts, impracticable to manage, may be listed for sale or other disposal. Several towns in the area have acquired tracts for cemeteries and for recreational purposes.



SECTION IV
NEEDS

NEED FOR ADDITIONAL DEVELOPMENT AND IMPROVED MANAGEMENT

In any area there is a need for greater utilization and more conservation of the available natural resources. The Black Hills area is no exception. In this section, these needs are expressed in quantitative and qualitative terms.

The projected needs or demands are indicators of what this area must provide for its people in the future. In some cases, two or more industries may be considering the use or development of the same basic natural resource. When this occurs, there will be a need to reconcile competitive uses.

SOCIO-ECONOMIC PROJECTIONS

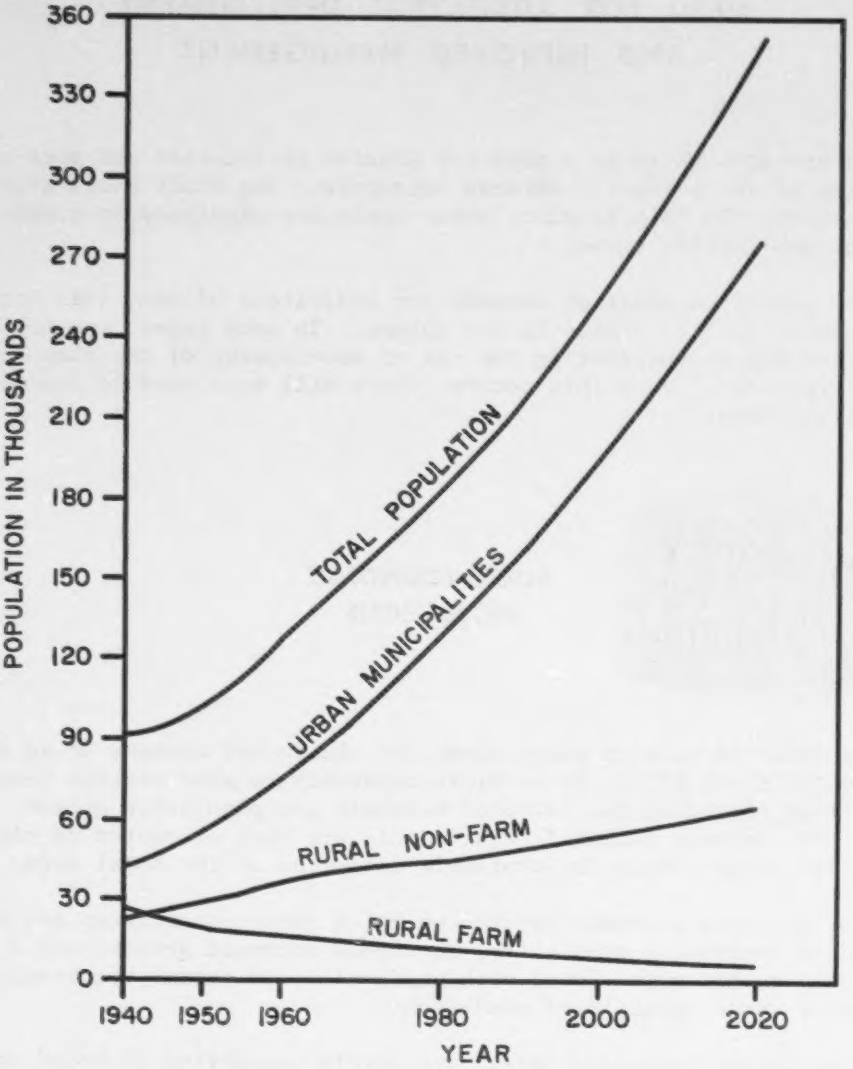
In order to develop projections for the future economy of an area such as the Black Hills, it is first necessary to make certain basic assumptions regarding the national economic and population growth rates. The overall national requirements are then allocated to the area under study within the available resources of the local area.

The national economic setting on which these projections are based assumes an increasing population, continued economic growth, and a relatively stable price level with production and demand requirements in balance under competitive conditions.

Projections presented herein are merely suggestive of broad trends that may be expected in the Black Hills area.

Population, Labor and Employment Projections and Distribution

Using the above basic assumptions, graph 15 presents population projections for the Black Hills area, urban municipalities, rural farm and rural nonfarm areas. Table 32 presents the population projections for the principal urban municipalities in the area. Table 33 presents projected employment by class of worker, and table 34 presents projected employment by industries.



GRAPH 15. BLACK HILLS AREA POPULATION, 1940-1960 AND PROJECTIONS, 1961-2020

Table 32.—Population for 1940, 1950, 1960, and population projections for 1980, 2000, and 2020 in nine municipalities in the Black Hills area

Municipalities	Population			Population projections		
	1940	1950	1960	1980	2000	2020
Rapid City	13,844	25,310	42,399	83,800	135,400	198,900
Belle Fourche	2,496	3,540	4,087	6,300	9,000	12,300
Custer	1,845	2,017	2,105	2,700	3,400	4,400
Deadwood	4,100	3,288	3,045	2,700	2,500	2,600
Hot Springs	4,083	5,030	4,943	6,000	7,500	9,700
Lead	7,520	6,422	6,211	6,000	6,400	7,500
Spearfish	2,139	2,755	3,682	6,200	9,000	12,500
Sturgis	3,008	3,471	4,639	7,500	10,800	15,000
Newcastle	1,962	3,395	4,345	7,700	11,300	15,800
Total	40,997	55,228	75,456	128,900	195,300	278,700

NOTE: The overall area population project has more reliability than projections for individual towns. An aggressive or a lax community development program very easily could pull a population development from one town to another. Induced activities, such as the airbase at Rapid City, could stimulate growth at a rate far in excess of that which might be projected.

Table 33.—Projected employment by class of worker, 1980, 2000, 2020—Black Hills area

Industry	Projected employment		
	1980	2000	2020
Agriculture	4,436	3,452	3,060
Manufacturing	4,845	6,789	8,742
Other commodity producing industries	9,609	11,317	14,947
Noncommodity producing industries	50,824	75,412	106,689
Total	69,714	96,970	133,438

Table 34.— Projected employment, by industries, for 1980, 2000, and 2020— Black Hills area

Industry Group	Projected employment		
	1980	2000	2020
Agriculture 1/	4,436	3,452	3,060
Mining	1,775	1,052	1,123
Construction	7,834	10,265	13,824
Manufacturing	4,845	6,789	8,742
Transportation	2,184	3,233	4,609
Communications	1,575	2,662	4,009
Utilities and sanitary service	1,237	1,871	2,679
Wholesale trade	1,876	2,879	4,150
Retail trade	11,186	16,274	22,883
Finance, insurance & real estate	3,385	5,807	8,803
Hotels and services	2,567	3,491	4,716
Other personal services 2/	21,792	34,173	49,818
Armed forces	5,022	5,022	5,022
Total	69,714	96,970	133,438

1/ Includes forestry and fisheries.
2/ Includes medical, professional, and public administration.

AGRICULTURE

Production Needs

As populations increase, the demand for agricultural products also increases. Table 35 indicates the estimated production required for certain basic commodities.

Table 35.– Agricultural production - Black Hills study area: 1949, 1954, and 1959, with projected production requirements for 1980, 2000, and 2020 1/

Commodity	Unit	1949	1954	1959	1980	2000	2020
		(Figures in thousands)					
All wheat	Bu.	2,996	1,667	2,016	5,565	6,693	7,812
Corn grain	Bu.	234	375	422	1,577	2,184	2,917
Oats	Bu.	1,190	995	645	902	1,350	1,835
Barley	Bu.	777	558	299	834	1,452	1,933
Potatoes	Cwt.	20	22	16	17	23	31
Milk	Cwt.	195	302	367	835	1,130	1,558
Eggs	Doz.	1,210	1,147	1,332	2,032	2,732	3,787
Beef & veal	Cwt.	1,172	1,805	1,388	2,475	3,471	4,875
Lamb & mutton	Cwt.	153	233	348	342	465	652
Pork	Cwt.	144	66	56	82	113	157

1/ Projections are preliminary and based entirely on historical shares of production by commodity.

These allocations of projected national agricultural requirements, based upon historical production patterns, indicate that production of most agricultural commodities in the Black Hills may need to be increased 2 to 6 times by the year 2020. All, or part, of this requirement can be satisfied in several ways. Advanced technology, additional dry cropland, and more irrigation are the primary factors that will lead to increased production.

Advanced technology offers the best opportunity to increase production. Better crop varieties, better livestock types, and more efficient farming methods will all contribute toward meeting more of the production needs of the future.

Soil and Water Conservation

Technical assistance is needed to develop soil and water conservation plans and help farmers and ranchers apply conservation treatment. The number of conservation plans needed is estimated at 2,300.

Federal financial assistance, through cost-sharing is needed as an incentive to farmers and ranchers to apply conservation treatment. It has stimulated development on watershed, irrigation and other group projects. The assistance goes mostly into those measures that provide the greatest community or public benefit and that provide long-lasting conservation benefits, and, in many instances, multipurpose use. Most cost-shared conservation treatment measures have high initial cost, and immediate returns to the farmer and rancher are limited.

Before high quality conservation plans can be developed on private lands and conservation measures applied, it is necessary to have adequate soils information. Soils information is not only valuable to farmers and ranchers, but is used by engineers and others designing urban sewerage systems, highways, and other developments. Soil surveys are also needed on all public lands. More than 9.5 million acres of land is in private ownership. Standard soil surveys have been completed on about 1.5 million acres. It would be desirable to complete the standard soil surveys on the entire area at an early date.

The demand for increased production emphasizes the need to protect the land. The Conservation Needs Inventory, completed in 1958, estimates the conservation treatment that will be needed by 1975 on private land. This inventory considers the conversion of land from one use to another prior to 1975. Table 36 reflects the principal practices that would be needed on: (1) Pasture and range; (2) irrigated cropland; and (3) dry cropland.

It would be desirable to have all the practices listed on table 36 applied by 1980. A realistic goal would be the application of at least 50 percent of such measures. For the years 2000 and 2020, no realistic projection can be made. By that time, advanced technology likely will develop alternate treatment practices that would not be consistent with today's need.

Administrators of Federal and State lands also have conservation problems that need immediate attention. Examples of measures and treatment needed on lands administered by the Forest Service and Bureau of Land Management are estimated as follows:

1. 2,300 acres soil stabilization
2. 1,326 water developments
3. 4,300 acres seeding
4. 1,182 miles fence
5. 381 cattleguards
6. 115 water control structures
7. 540 miles roads and trails requiring erosion control, drainage, and/or seeding

The basic need for agricultural research is more demanding today than it has been in the past. Past research has made a great contribution to present production but, to meet future needs, research programs will have to be broadened. Once the knowledge is acquired, it has to be disseminated. More technicians will be required to plan and apply these agricultural research findings on private as well as public lands.

There is a continuing and urgent need for expanded research to provide a pool of information on resource problems of agricultural and rangeland watersheds. Information is needed concerning precipitation amounts and intensities, runoff, land treatment practices, types of vegetation and plant management, streamflow, sedimentation, stream

Table 36.—Conservation treatment needs on private land estimated for 1975

	Pasture and range						
State	Grass seeding 1/ (ac.)	Deferred grazing (ac.)	Proper range use (ac.)	Water 2/ developments (no.)	Water spreading (ac.)	Diversions (mi.)	Fish pond treatment (no.)
South Dakota	216,500	813,000	1,470,000	9,650	118,900	570	590
Wyoming	31,400	450,000	1,805,500	2,375	111,600	380	305
Total	247,900	1,263,000	3,275,500	12,025	230,500	950	895

	Cropland (irrigated)						
State	Proper irr. water use (ac.) 3/	Land leveling (ac.)	Irr. field ditches (mi.)	Ditch & canal lining (mi.)	Irr. reservoirs (no.) 4/	Sprinkler irr. systems(ac.)	Mains & laterals (mi.)
South Dakota	95,200	60,400	3,400	335	60	14,600	45
Wyoming	20,800	12,700	160	30	80	--	3
Total	116,000	73,100	3,560	365	140	14,600	48

	Cropland (dry land)						
State	Terraces (mi.)	Contouring strip (ac.) 5/	Wind strip cropping (ac.)	Waterways (ac.)	Stubble mulch (ac.)	Grade stab. structures (no.)	Wildlife hab. pres. (ac.)
South Dakota	148,100	98,300	174,600	3,700	273,200	410	3,200
Wyoming	2,500	218,000	4,000	350	55,100	290	3,550
Total	150,600	316,300	178,600	4,050	328,300	700	6,750

1/ Includes pasture and hay planting and range seeding.
2/ Includes farm ponds, springs, wells.
3/ Includes present and projected need.
4/ Includes reservoirs for individual operators.
5/ Includes contour strip cropping and contour farming.

Photo 15. Furrow irrigated corn near Spearfish, South Dakota.

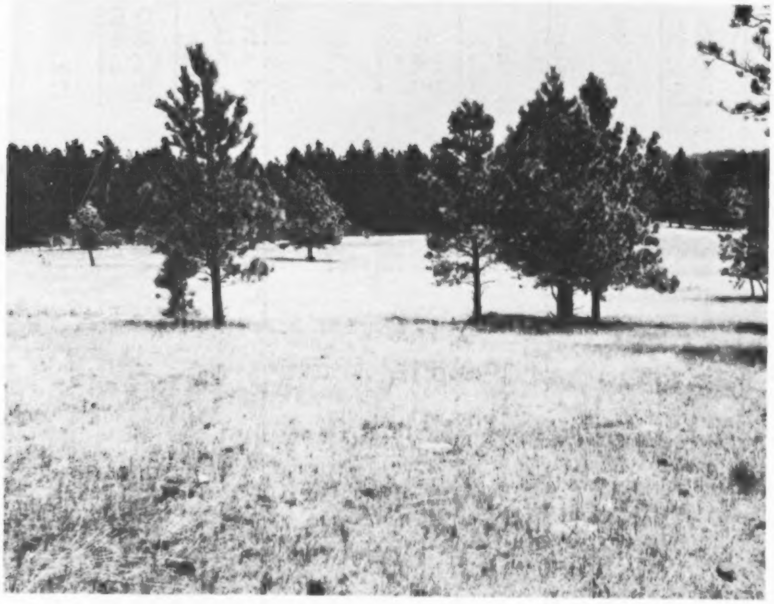


Photo 16. Rangeland with woodland in background, southwest of Rapid City, South Dakota.

Photo 17. Stubble mulching in area east of Sturgis, South Dakota.

Photo 18. Contour stripped and terraced cropland. Rotation 1/3 alfalfa, 1/3 small grain, and 1/3 corn and summer fallow. Land class II with average slope of 4 percent.

channel stabilization, pond and reservoir losses of water and storage capacities and water quality. Existing and contemplated developmental projects to be effective and sound must be based on reliable and proven principles and relationships. An expanded research program centered, for example, at Rapid City, South Dakota, is needed to provide the basic information to backstop action programs of the area.

Need for Credit

With the expected expansion in resource development and in the use of land and water resources, the agriculture picture also will change.

Credit in ever-increasing amounts will be needed to meet both the traditional agriculture needs and the demands for development of timber, recreation, and fish and wildlife by individuals, municipalities, associations, or other public bodies.

Expanded use of agricultural credit, both to individuals and associations or public bodies, for recreation and forestry should be encouraged. Rural communities will have a greater need for credit for sewer, water, individual and rental housing, and recreation facilities.

TIMBER

Existing and Future Needs for Timber Products

Production of lumber and other wood products never has come close to meeting the productive capacity of the area. On occasion, lumber production has approached the sawtimber segment of the growing capacity. However, considering the study area as a whole and the full range of timber products that it is able to produce, a wide gap has existed between growth and the amount actually utilized.

Much of the increasing timber demand can be met by the year 2000 by closing the gap between growth and utilization. However, 34 years (1966-2000) is a relatively short period of time in relation to the economic life of a tree, which is about 120 years in the Black Hills. Therefore, to meet the expected demand beyond the year 2000, action must be taken now to increase productivity. As the growth rate is steadily increased, the annual allowable cut will be increased to keep pace with growth.

A review of sawtimber production data indicates the wide difference between sawtimber ready to be cut and that actually cut. For the period 1961-65, the average annual sawtimber cut was about 52 million board feet, compared to an estimated annual allowable cut of 98 million board feet.

The greatest need for increased utilization of timber products exists with roundwood. During 1961-65, the average annual roundwood consumption was 60,000 cords, while the estimated allowable cut was 260,000 cords. Recent consolidations within the industry improved efficiency and new methods indicate roundwood production will increase sharply in the next few years. The harvest is expected to be over 130,000 cords annually by 1970.

There is a need to expand the post and pole industry. Interest must be stimulated to increase production to meet current demands. The quality of the final products must be improved through treatment.

Timber Stand Improvement and Reforestation

To attain maximum timber production throughout the Hills will require full regulation of all timber stands. Growing stock must be treated now to achieve and maintain proper distribution of age and size classes and desirable intensities of stocking later. There is need to accomplish the following:

1. Concentrating harvest cutting on removal of old growth stand remnants on 600,000 to 700,000 acres that have been partially cut and subsequently restocked with young trees.

2. Thinning these young trees to place the stands in vigorous growing condition.

3. Making similar precommercial thinnings on about 64,000 acres of sapling stands already free of old growth overstory.

4. Thinning approximately 500,000 acres of dense, overstocked pole stands—called "commercial thinning" because the cut material is usable in the market.

5. Continuing restoration of timber cover on deforested areas, carefully coordinated with needs for and improvement of critical wildlife habitat. Confine this work to the very best timber producing sites.

The indirect effects of timber stand improvement are also important. A timber stand intercepts and reduces the amount of precipitation that eventually reaches the ground. Stands may intercept one-fourth or more of the precipitation from heavy rain showers or from snowfall, and up to 100 percent from light showers.

A potential for substantial gains in genetic improvement of wood quality depends on the development of a research program of controlled interbreeding of selected superior trees. If Black Hills ponderosa pine is to compete with wood products from other regions, the general level of local wood quality must be steadily raised. Limited advances toward that goal may be made by selecting seed for nursery stock from better than average stands. The most satisfactory answer to this problem in the long run, however, seems to lie in the development of strains or races of pine that are inherently superior in quality to those presently growing.

Closely associated with development of better ponderosa pine is the equally intriguing prospect of introducing other species or hybrids. There may well be nonnative species that would adapt to the local environment. If so, their introduction could produce multiple benefits, including improved site utilization, product diversification, increased crop values, and reduced vulnerability to damage from insects, disease, and fire.

Needed Protection and Development

This section considers only protection against insects and disease and other biotic influences. Protection against fire is covered under management aids.

Stagnated timber stands are close-growing and overstocked. Under the heavy competition for water, nutrients and sunlight, many trees slowly weaken and die through natural thinning. The vigor of surviving trees may decline, rendering them more susceptible to insect and disease attack.

As cultural investments in the timber stands increase, so will the need for more effective protection measures. Insect outbreaks, while not as spectacular as wildfire, can be more devastating. Just as with fire, it is important to stop outbreaks close to the source, while small. The bark beetle epidemic of 1963-64 emphasized the need for close coordination and cooperation between all landowners. On timberlands where this effort was lacking, the beetle problem not only persisted but renewed the threat to adjacent lands where control was obtained. Where adjacent lands are endangered by insect or disease attack, authority permitting quick action by the State forester is imperative.

Better means for control of insects on privately owned timber lands is urgently needed. Frequently, the private timber owner is unaware of the threat or does not have the finances to control an outbreak on his land. Federal, State and private land managers who are expending effort and money for control are often confronted with potential reinfestations from adjoining lands where control is lacking. Constant cooperation between land managers and land managing agencies will be required to insure that the total job is done effectively and at a minimum cost.

More research is needed in the entire field of protection. Black Hills bark beetle control would become more effective with the development and use of insect attractants, insect predators and selective insecticides.

What has been said in regard to insects also holds true for disease. The incidence of disease is generally lowest in healthy, vigorous growing stands. Logging frequently proves to be the most effective and economical control of tree disease.

Improved Management

Technical assistance.—Providing technical forestry assistance to the private landowner enhances his opportunity for sustained economic benefit from his timber crop. Such assistance is normally provided by the State Forester's office under the various cooperative forestry programs. There is an existing need for additional professional foresters in State agencies, particularly in the Wyoming section of the area.

Cost sharing.—Cost sharing with States and private landowners is generally adequate for most programs at the present time, except for insect control. Areawide, more funds eventually will be needed in order to meet growing needs for assistance in all cooperative forestry programs directed toward industry, State and local government and private timberland owners.

Conservation activities need to be expanded through:

1. Intensive inventory of State and private forests.
2. Title IV planting program (Agricultural Act of 1956).
3. More extensive use of the Agricultural Conservation Program, such as the A-7 and B-10 practices.
4. Program for planting site preparation.

Other.—A continuing need will exist to intensify all efforts in the fields of utilization and marketing research. There is a need to develop markets for all products, to investigate and develop new uses for wood products, and to develop methods of producing them economically. The economics of manufacturing 4x4 plywood in the Black Hills appears more favorable than producing 4x8 panels, because of the size of the raw material available. However, the market potential for 4x4 panels is relatively unknown at this time. It appears that with an increase in Cooperative Forest Management, and the additional need for research, that there will be need for State utilization and marketing specialists as well as re-establishing a marketing and utilization project at the Forest Research Center at Rapid City.

Local loggers need assistance and encouragement in trying newly developed logging equipment. This is especially true where it concerns roundwood logging. The increased demand placed on local producers will necessitate their developing faster and more economical methods of production.

A study is needed of the present system of taxation of forest lands to determine if present taxing methods are realistic and equitable to the landowner for long-term timber production.

MINERALS

National Needs

The people involved in the Black Hills mineral industry are dependent upon the availability of national, regional, and local markets for various mineral products. Bentonite and the pegmatite minerals enter the national market directly. Gold and uranium are sold to agencies of the Federal Government, and are re-allocated to consumers. Such commodities as petroleum and natural gas, cement, lime, brick, and lightweight aggregate enter the local and regional markets. Rock, sand, and gravel are fairly well confined to a local market area of about 200-mile radius.

The following 1964 data (from the 1964 Minerals Yearbook) are illustrative of the national and international demand for gold:

World gold output (mine)	46.1 million Troy ounces
U. S. production (mine)	1.5
Black Hills production (mine)	.6
U. S. industrial consumption	4.8
U. S. imports	1.2
U. S. exports	12.1
U. S. monetary stocks (12/31/64)	15.5

The Federal Government is committed to purchase all newly mined gold at a fixed price of $35.00 per ounce. Thus, gold mining is limited only by the narrowing margin between production costs and the set price for the finished product. In an effort to reduce costs, Homestake recently has increased milling capacity to what is believed to be its optimum rate at the present price for gold.

As of 1965, ore reserves at Homestake were given as 16.8 million tons of measured ore (assay value $11.01 per ton) and 2.7 million tons of indicated ore ($11.63 per ton). This represents a 9.7 year reserve at the present mining rate. In the past 30 years during which geological studies have been applied to estimation of reserves, it has been possible to discover and block out new ore each year equal to, or in excess of, that removed by mining. Thus, the future for total estimated reserves has remained essentially constant. The known reserves on properties other than Homestake are very limited.

Gold production to the years 1980, 2000, and 2020 has not been projected.

Uranium.--The present need for uranium production is largely dictated by national defense and nuclear power requirements. Uranium ore reserves of the nine-county area probably do not exceed one-fifth of 1 percent of the total U. S. reserves. The latter were estimated by the Atomic Energy Commission at 74 million tons containing 0.28 percent U_3O_8. Although the largest part of the known Black Hills area reserves will be depleted before the scheduled termination of the AEC contract with the Edgemont mill of Mines Development, Inc., by June 30, 1967, some reserves will remain unmined. Countless small prospects have not been explored because of the decision of the AEC to make no further buying commitments for ores developed after November 24, 1958. Although it seems unlikely that any of these can maintain production without a government guaranteed price and market, they remain as a small reserve for future use, or in case of a national emergency.

Feldspar.--Because transportation costs to distant markets seem to be the controlling factor limiting production, development of a local demand for feldspar appears to be the best means of stimulating the industry. The Black Hills has produced roughly 7 percent of the Nation's output of feldspar in recent years. The principal producers, North Carolina, California, Connecticut, Georgia, and South Carolina, are appreciably closer to the principal feldspar consuming States of Ohio, California, New Jersey, Illinois, and Pennsylvania. South Dakota dropped from a peak annual production of approximately 75,000 tons of hand-cobbed feldspar to about 40,000 tons when milling methods were devised to recover feldspar from fine-grained, feldspar-rich, igneous rocks, especially in North Carolina. New milling methods are needed to help the Black Hills area compete with other areas.

Mica.--The experience of the two World Wars has demonstrated that the Black Hills pegmatites can produce vital quantities of high-grade sheet mica under the stimulus of artificially high, guaranteed prices. During normal times, imports provide necessary supplies at a price with which local producers cannot compete. There is no local market for mica.

Beryl.--Beryl production also can be stimulated by guaranteed high prices in time of emergency. Because of the low beryl content of most pegmatites, beryl normally can be produced only in conjunction with feldspar, mica, or lithium minerals. Traditionally, beryl has been recovered by hand-cobbing methods. Experiments have shown that beryl

Photo 19. Feldspar grinding plant at Custer, South Dakota. Feldspar from company mines and those of individual producers is ground here prior to shipping.

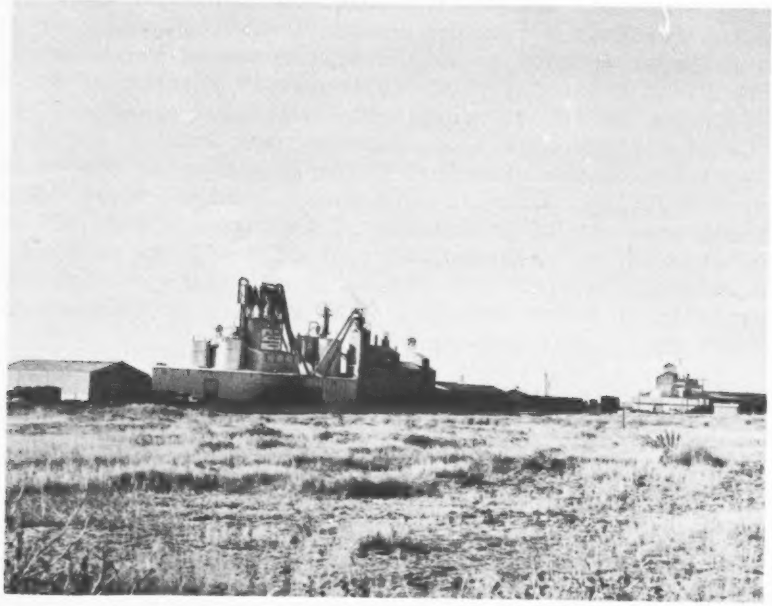


Photo 20. Bentonite plants at Belle Fourche, South Dakota. Plant at left processes bentonite mined by the company in South Dakota and Wyoming. Bentonitic clays processed at the other plant are mined by the firm in Wyoming.

also can be recovered by flotation techniques, but the small content of beryl in known Black Hills pegmatites discourages attempts of recovery by this method at present prices.

Lithium minerals.--A national emergency, or increased demand for other pegmatite minerals, would encourage production of limited quantities of lithium minerals from the Black Hills. Although the Black Hills area was once a leading producer of such lithium ores as spodumene, amblygonite, and lepidolite, production has dropped to virtually nothing at present. Recovery of spodumene from fine-grained rocks in North Carolina and recovery of lithium brines of western lakes account for most of the present production in the United States.

Other minerals.--Potential production of columbite-tantalite, tin ore, and cesium ore is so small that production needs are not discussed.

Area and Local Needs

Petroleum and natural gas.--Production of crude oil in the nine-county area far exceeds present refining capacity; much crude leaves the area by pipeline, and finished products enter the area from outside refineries. Recent expansion of local refining facilities has been mentioned in section III. Active exploration for oil and gas is now in progress in Weston and Crook Counties, particularly; several small but significant fields have been discovered in each of the past five or six years. Wyoming has no prorationing except as production must be limited by pipeline capacity. Pipelines are built as reserves justify their construction. The present shortage of crude oil in the Rocky Mountain area assures a ready market for any oil discovered.

The nine-county area is deficient in natural gas production; only Newcastle is supplied with locally produced gas. Belle Fourche, Lead, Deadwood, Sturgis, Rapid City, and Ellsworth Airforce Base depend on gas from central Wyoming and western North Dakota. The town of Sundance soon will receive gas from a new pipeline entering the Black Hills from central Wyoming.

Cement.--The Black Hills area is self-sufficient in Portland and masonry cement, and has a surplus available for regional distribution. The marketing area is fairly well prescribed by shipping costs, as discussed in section III. Production and sales, then, are dependent upon demand of the construction industries within that area. In 1965 the State Cement Plant at Rapid City operated at about 51 percent of capacity, marketing 1.8 million barrels per annum. The Cement Commission owns reserves of limestone that are adequate for many years' operation at the 1965 rate, and supplies of shale, and lesser additives, are essentially limitless.

Brick and other ceramics.--The market for common brick and tile is definitely limited by shipping costs and location of competing plants in surrounding States. Production is entirely dependent upon demand within the prescribed area. But, because architects and builders will pay a premium for particularly pleasing colors and textures of face brick, the latter may be sold throughout a much larger area. The local brick industry, having a variety of clays to draw upon, modern facilities, and production capacity well beyond present market demands, is in an excellent position to compete in adjacent market areas.

Lime.--The market for high-quality lime products is limited both by the competition of other plants located on good sources of raw material and by shipping costs to intermediate points. The Black Hills area is ideally located in this respect, and with increased demand for lime (particularly for highway stabilization) in the area, it is possible to support a new and rapidly expanding industry. Announcement recently has been made of plans to expand greatly the facilities described in section III. Adequate reserves of high-grade limestone make even further expansion possible.

Lightweight aggregate.--The lightweight aggregate plant at Rapid City serves most of South Dakota, and adjacent parts of Wyoming, Montana, and Nebraska. About 50 percent of the product is manufactured into Haydite block at the Rapid City plant; the remaining half is shipped as aggregate for manufacture of block in other centers of construction, or for use as bulk aggregate. The present facility at Rapid City operates at approximately half capacity, and has access to unlimited reserves of high-grade bloating shale.

Rock.--Local and regional demand is easily met by existing quarries and preparation facilities. The market for crushed rock, riprap, flagstone, and other rough forms is limited practically to a radius of 200 miles beyond the borders of the Black Hills; additional markets must be generated by construction demands within this limit. Quarries are well located with regard to shipping facilities, and because they have excess productive capacity in almost all instances, production could be greatly increased if conditions warranted.

Need for Conservation

Conservation in the mining industry is tied to many factors, of which four are dominant: (1) Price for the product must be high enough to permit mining of low-grade, presently submarginal ores in existing or new properties; (2) improved beneficiation techniques must be devised to permit higher recoveries from all material mined; (3) wise use must be made of the products produced; and (4) improved safety practices may permit mining of ore in areas now considered hazardous or uneconomic.

In the Black Hills area, higher mineral prices would encourage mining of smaller or leaner sections of ore deposits or pegmatites, thinner beds of bentonite and coal, and would permit mining of deposits of all types which are now considered too deep to permit economic removal of overburden.

Milling techniques applied to the pegmatites could give essentially 100 percent recovery of all marketable minerals, compared with 10 to 50 percent by present hand-picking methods. An economic process for upgrading nonswelling bentonites, either blue or yellow, would greatly increase reserves. Even more beneficial would be improved means of secondary recovery of oil, particularly from the Cretaceous sandstone fields of Weston County. An engineering study in 1955, in part of the Greater Clareton area, concluded that by primary means of production, only 12.6 percent of the crude oil could be recovered, but that by a secondary recovery program consisting both of gas injection and waterflooding, the total recovery might be raised to 30 percent. Seventy percent of the oil originally in the reservoir remains unrecoverable by present economic recovery methods.

Reclaiming of bentonite strip-mining pits ultimately may become desirable wherever such land is needed for other purposes. Some oil and gas drilling sites might even be reclaimed in time.

RECREATION

Despite the tremendous opportunities and investment in both the public and private sectors of the recreation-tourism industry, requirements for the future are great and complex. A three-step process is used to describe these requirements. First, existing demand for recreation that cannot be satisfied because of insufficient facilities or opportunities is discussed as "unfulfilled demand." Some refer to this as "latent demand." Second, future public demands are covered narratively and in projections of "activity-days" and visitors. Finally, requirements for additional facilities and opportunities to meet these future demands are described and referred to as "needs." Needs are shown graphically and narratively.

Unfulfilled Demand

The most significant unfulfilled demands are in water-based recreation activities, but unfulfilled demands in land-based activities become quite noticeable during peak periods of use. For water-oriented activities, the greatest amount of demand goes unsatisfied in swimming and fishing, while opportunities for boating and water skiing could fall well short of the demand in the near future.

In land-based activities, the greatest amount of unfulfilled demand appears in hiking and is directly attributable to a lack of good trails.

The unfulfilled demand in sightseeing is relatively small because most visitors tolerate crowded highways and tourist centers. Moderate amounts of hunting and winter sports demands go unfulfilled, with much of the latter due to a lack of skating and sledding opportunities. Minor amounts of unfulfilled demand occur in camping and picnicking. Generally, the greater the unfulfilled demand, the greater will be the development efforts needed in the near future to help make up the deficits.

Future Demand

A number of socio-economic and other forces are pushing recreation use ever higher. One of the most obvious is increasing population, but use is increasing even faster than the population. The most important other factors are the growing increases in disposable income and leisure time. Significant but less important forces include shifting numbers in various occupational and age groups, increasing educational level and mobility, and changing attitudes toward outdoor recreation.

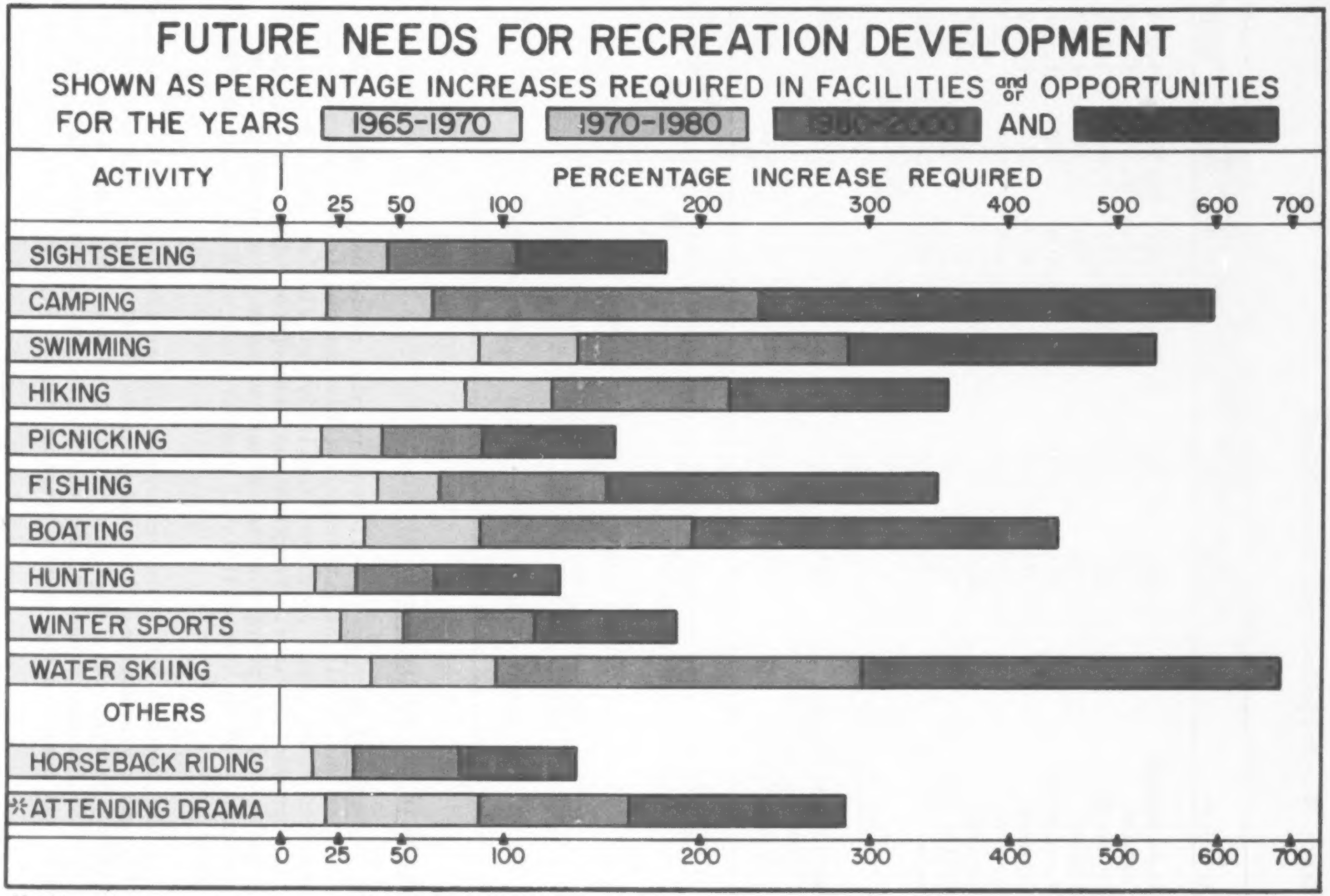
Future Trends

In general, the trends described in section III will continue. Increased popularity will be most noticeable in swimming, fishing, boating, water skiing and hiking, if sufficient opportunities are provided. The current camping boom is expected to continue. Winter sports could see a large upsurge of interest if the snow shortage and other problems are resolved. The range in visitor preferences will become even greater than it is today. For example, many will wish to tour the area in a great hurry while others leisurely drive the old, narrow highways. There is expected to be more interest in nature and history. The demand for luxury facilities and developments will increase.

Table 37 shows the projected demands in "activity-days" for 10 primary and 2 less significant recreation activities for selected years between 1960 and 2020. The bottom portion shows projected visitor totals on the basis that each individual engages in approximately 3 activities per day of recreation.

Recreation Needs for the Future

Graph 16 shows needs for recreation development as percentage increases required in facilities or opportunities (by activity) for future target years. The base year is 1965. The 10 primary activities are listed in descending order of projected popularity for 1980, as in table 37. As can be seen in comparing the table with the graph, some of the less popular activities, such as boating and water skiing, show some of the greatest increases in needs for future development. Needs for the public sector are grouped below under the categories of "improved management," "land-based" and "water-based recreation."



FUTURE NEEDS FOR RECREATION DEVELOPMENT

SHOWN AS PERCENTAGE INCREASES REQUIRED IN FACILITIES and or OPPORTUNITIES FOR THE YEARS

*Attending Outdoor Drama and Concerts

GRAPH 16

Table 37.—Projected recreation demand

Activity	Activity-days (in thousands)[1] 1960	1965	1970	1980	2000	2020
Sightseeing	5,824	6,286	6,766	8,167	11,540	16,053
Camping	622	758	911	1,264	2,587	5,317
Swimming	781	885	993	1,262	2,078	3,411
Hiking	587	639	692	850	1,228	1,777
Picnicking	446	480	511	608	829	1,131
Fishing	375	419	464	553	942	1,529
Boating	169	194	223	289	494	855
Hunting	229	242	254	275	371	499
Winter sports	194	215	237	274	391	537
Water skiing	50	60	71	101	205	407
Others						
Horseback riding	166	174	184	224	300	400
Attending outdoor drama, etc.	130	159	196	296	431	630

[1] An activity-day is any part of a day spent participating in a particular recreation activity.

Total number of visitors expected (in thousands)

1960	1965	1970	1980	2000	2020
2,500	3,000	3,600	4,500	7,100	10,900

Needs in the Public Sector

Improved management will require more coordination between all agencies and levels of government within the public sector to provide balanced development programs, facilities of similar quality-level and improved services. Programs and developments that conflict or compete with the private sector should be kept to a minimum. Most agencies need to hire additional planners and utilize better design techniques.

The Federal and State sectors should continue to provide facilities and opportunities that emphasize aesthetic values and outstanding natural attractions. Emphasis should be placed on clean, durable, attractive, properly spaced, and amply supplied facilities that complement and preserve the natural surroundings. High priority should be given to the upgrading or replacement of worn or overcrowded existing sites.

There is a need for full participation in and better financing of State, county and community recreation programs. More comprehensive programs are needed for gathering and analyzing data on visitor use, preferences and needs.

Future development and promotional emphasis should be placed on the type of recreation the area can supply in greatest quantity. As will be seen in section V, this is the area's land-based recreation potential. Keeping up with the demand for land-based recreation, especially sightseeing, camping, picnicking and hiking, will require continuing major expansion of facilities and development of new attractions, while retaining several semiwild and open areas.

There is need to find ways of making existing scenic highways safer and capable of handling more tourists, while retaining the roads' unique characteristics and the beauty of the adjacent scenic resource. Additional winding-scenic highways will be required. More vista-point parking areas and rest stops are badly needed, especially in the Hills.

Information-interpretive facilities and other instructive developments for visitors at and near primary attractions will require continuing expansion. There is a need for full participation in such programs by all agencies having major recreation interests. More dynamic efforts are needed in identifying, preserving and developing important historical sites, and in emphasizing other special assets of the area.

All sectors should participate in meeting camping and picnicking needs, utilizing varied types of sites. There is a pressing need for many more hiking, riding and nature trails. An accelerated development program is needed now with regular expansion following. The Forest Service alone has estimated its needs at 150 miles of new trails by 1975.

The public and private sectors both should put more emphasis on facilities, opportunities and promotional efforts that will encourage greater participation in spring, fall and winter activities.

Major increases are shown on graph 16 for all future water-based recreation needs. Trends indicate that all water-oriented recreation areas in the area will require full development by about 1985. Before that time, existing reservoirs and lakes in the central Hills should be fully developed for camping, picnicking, hiking and water sports activities. By 2000 it would appear necessary to develop all potential recreation reservoirs. For the next 10 to 15 years, in particular, emphasis should be placed on greater and more efficient utilization of existing reservoirs and stream areas. At the same time, it will prove wise to develop several new reservoirs, especially cold-water lakes in the Hills area.

Photo 21. The Black Hills will require more scenic highways in the future to meet sightseeing needs and retain the character for which the region is famous. Photo taken of "pigtail" curve and narrow tunnel on U. S. Highway 16A near Mount Rushmore Memorial.

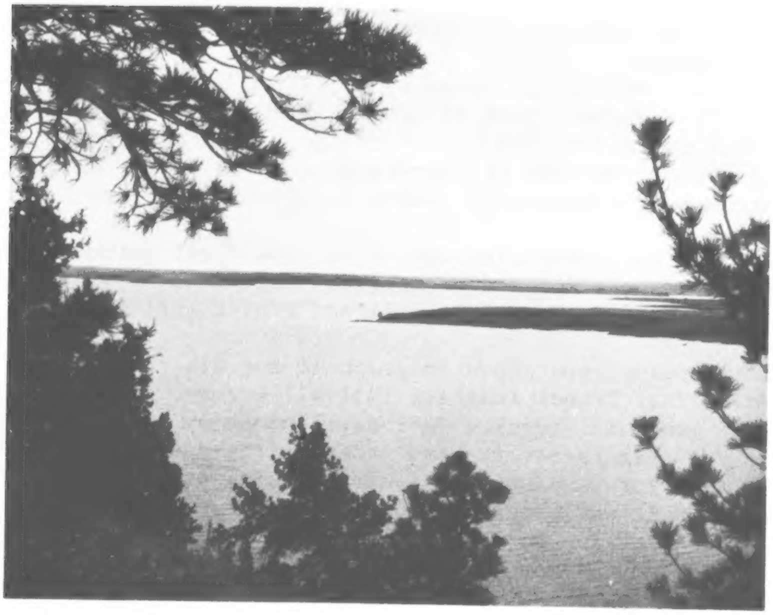


Photo 22. All existing major bodies of water, including Angostura Reservoir, shown here, will require full recreation development within about the next 20 years to meet waterbased recreation needs.

There will be a need for more stream and lake-oriented parks in built-up areas and town centers. All public agencies and communities should share in providing water-based recreation; many small bodies of water are needed, and all have a responsibility to participate.

Needs in the Private Sector

Needs within this sector are treated by the five "development categories" described in section III. Motels, hotels and lodges are generally handling tourist requirements rather well, but a few problems are noticeable. As for all private developments, there is a need to lengthen the profit season and even-out use more during the week and season. More deluxe establishments and a limited number of inexpensive, simple accommodations and dude ranches will be required.

In the private campground-trailer park industry, there is a need to increase the number and percentage of attractive deluxe camps. Common are needs for more sanitation facilities, shade, swimming pools, and other water areas.

Additional attractions will be required, but an obvious objective would be for more quality attractions and fewer developments that offend the eye, the pocketbook, and the majority of other operators.

The future will see a need for more bus, limousine, jeep and guided tours and chairlifts, tramways and horseback riding facilities. Great popularity is expected for old, authentic trains and train rides.

Additional golf courses, swimming pools, beaches and other sports facilities will be needed, both as individual developments and in connection with lodges, campgrounds, and other developments.

In summary, problems and needs of the private sector are varied, but to the owner, they are largely economic. Competition is strong and the season is short. The basic need is a matter of inducing more people to come earlier, stay longer and later, spend more money and leave happy enough to want to return again soon.

FISH AND WILDLIFE

Present and Future Demand for Fishing and Hunting

Essentially, demand can be visualized as consisting of two components: expressed demand, the actual use of the resources and unfulfilled demand, the use over and above expressed demand that would occur if the fishing and hunting opportunities were optimum. Together they represent potential resident demand of the nine-county area.

Potential resident demand is a calculated theoretical demand for fishing and hunting based upon demonstrated use where fishing and hunting are abundant for a population with comparable socio-economic characteristics to the residents of the Black Hills. It reflects the total satisfaction of latent demand for these activities and is valuable in weighing the desire of people for fishing and hunting (table 38 and graphs 17 and 18).

The potential resident demand is not well suited as a practical goal to use in planning because nonresident hunting and fishing are not reflected by it. Therefore, an estimate of Black Hills resident demand based on present trends is also provided. Residents of Wyoming and South Dakota living outside the nine-county area but going there to hunt and fish are assumed to equal Black Hills residents leaving the nine-county area to fish and hunt in other parts of their respective States. Out-of-State demand was added to the resident demand to produce total demand.

The total demand estimates suggest that by 2000 the total fishing demand will exceed the 1965 maximum capacity. By 2020 the resident demand will be over three times as great as the present basic capacity and use. Obviously, large increases in the base capacity will be needed to satisfy the future resident and out-of-State fishing demand unless the highly artificial put-and-take management effort can be accelerated to absorb the pressures for more fishing. For a discussion of the maximum capacities through put-and-take management, see section V.

The 1965 hunting capacity and projected future capacities are shown in graph 18 (also table 30). If present hunting quality is to be maintained, only moderate increases are possible in Black Hills hunting capacity; therefore, it seems unlikely the resident demand can be met much beyond 1990, let alone provide for out-of-State increases. If

Table 38.– Black Hills projected fishing and hunting demand (use) for 1960 through 2020

Item	All figures in thousands			
	1960	1980	2000	2020
Potential resident demand (man-days)1/				
Fishing	435	659	925	1,306
Hunting	294	514	746	1,024
Demand (man-days)2/				
Fishing resident	207	406	725	1,203
Fishing nonresident	93	147	217	326
Fishing total	300	553	942	1,529
Hunting resident	150	220	316	444
Hunting nonresident	56	55	55	55
Hunting total	206	275	371	499

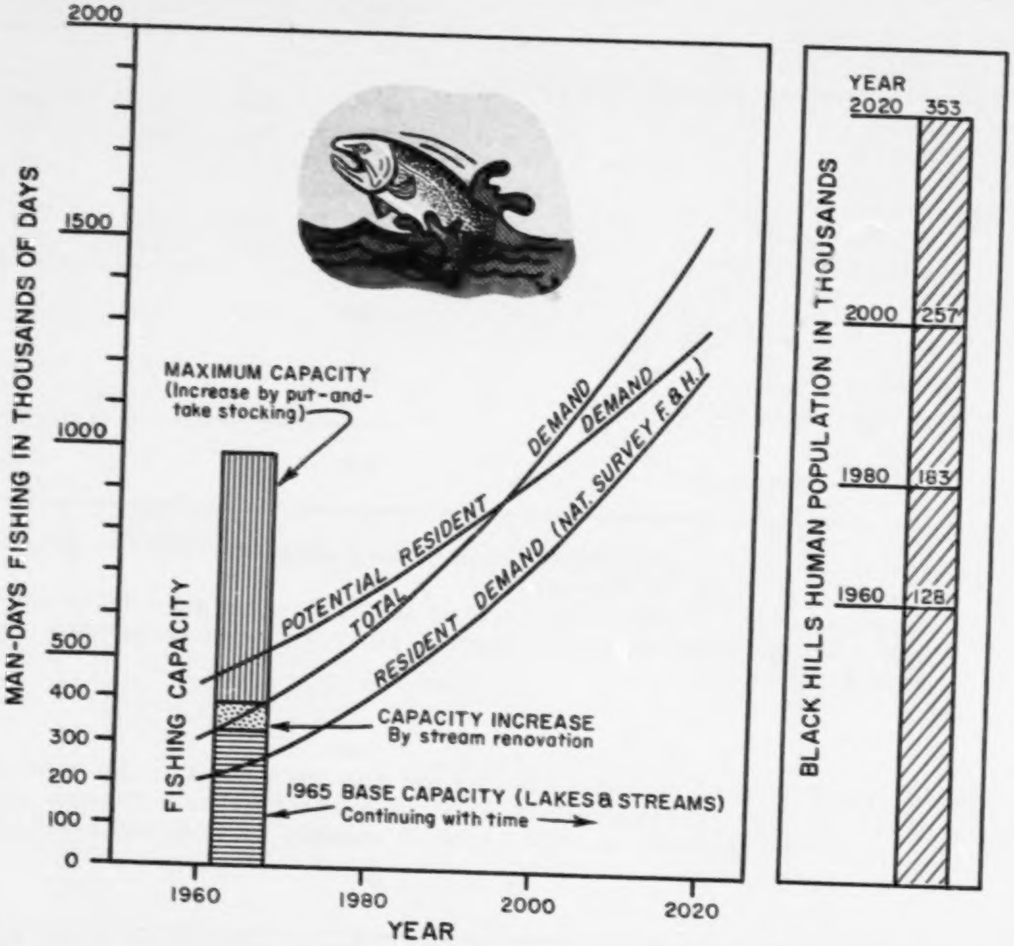
1/ Black Hills total population (nine-county area) x estimated man-days demand per capita (table 39).

2/ Discrepancies between total hunting and fishing on this table and on table 37 and graph 16 result from slightly different inventory methods.

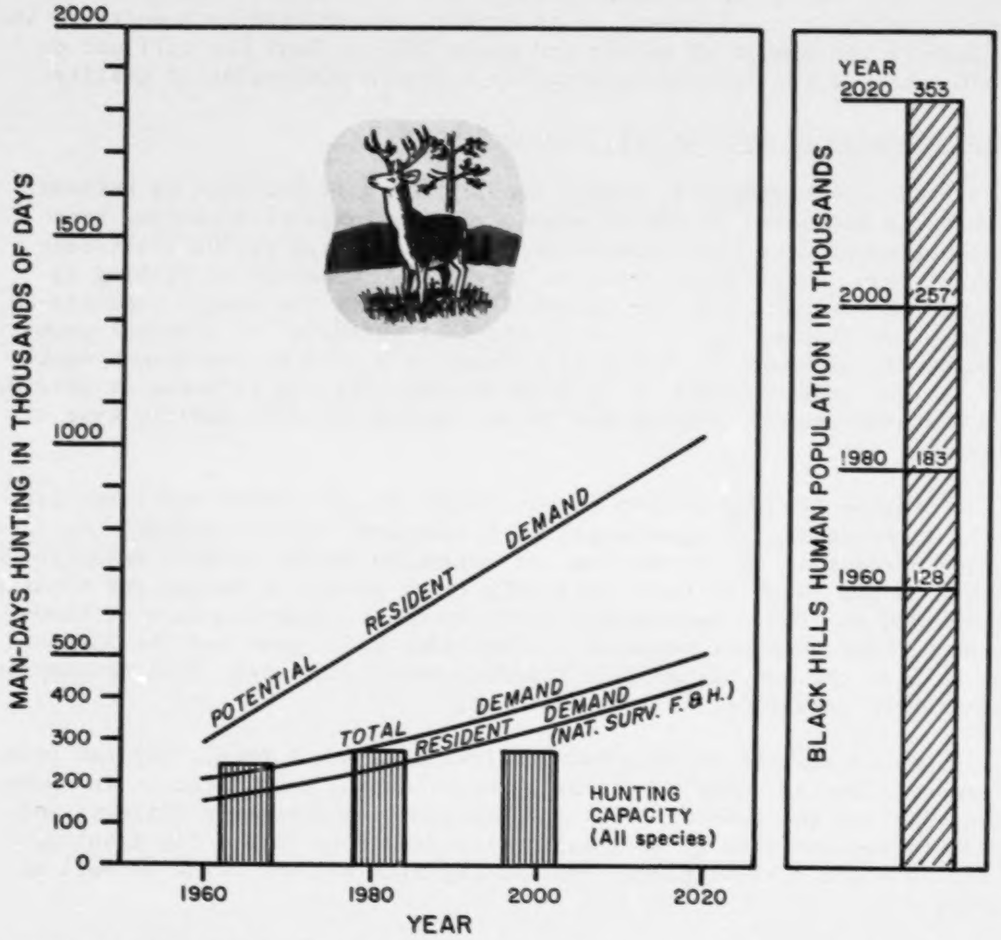
Table 39.– Potential resident fishing and hunting demand in man-days per capita (total population) for the Black Hills. Changes from 1960 to 2000, to 2020 based on changes in five socio-economic categories with time 1/

Activity	Man-days demand per person - All ages			
	1960	1980	2000	2020
Fishing	3.4	3.6	3.6	3.7
Hunting	2.3	2.8	2.9	2.9

1/ Socio-economic categories included were (1) income, (2) education, (3) occupation, (4) age-sex, and (5) leisure.



GRAPH 17. FISHING CAPACITY, DEMAND ESTIMATES AND POPULATION CHANGES, 1960-2020, FOR THE BLACK HILLS AREA



GRAPH 18. HUNTING CAPACITY, DEMAND ESTIMATES AND POPULATION CHANGES, 1960-2020, FOR THE BLACK HILLS AREA

hunting demand continues to increase, and if resident demand is to be met satisfactorily, or near the historical level, out-of-State hunting will have to be sharply curtailed by 1980 to maintain the present quality. By 1990 the resident hunting will be at the expected capacity. Beyond this date, the present hunting quality cannot be maintained if the resident or total demand is to be met. There will be a definite increase in the number of people who would like to hunt but will not do so because of the lack of opportunity and/or a diminution of quality.

Determination of Hunting and Fishing Needs

The base capacity to supply trout fishing is exceeded by current use by an estimated 73,000 man-days, while warm-water fisheries have capacities greater than present use by an estimated 62,000 fisherman-days. This leaves a net total of only 11,000 man-days of fishing in excess of current total use (graph 17). Whether the excess capacity in warm-water fishing can be used to its full potential is somewhat problematical, although it should be pursued as a goal by management agencies. The critical need is to provide trout fishing in lakes or streams to meet the obvious present and future demand for this quality type of fishing.

Because fishing is very popular with all age groups and lends itself to expansion of opportunity by development and management, the major needs rest in restoration and expansion of the fishery resource. Table 38 and graph 17 indicate a very large growth in demand for fishing from 1960 to 1980. Data beyond 1980 represent a continuation of known trends. The economic benefits to the Black Hills area and the Nation, as well as the many intangible benefits associated with full development of fishery resources, will be enormous.

Needed changes in fish and wildlife management trends include problems of altering aquatic habitat types, creating more interest in abundant species (warm-water fish) through public information efforts, and encouraging sporting as well as harvest practices (i.e., fly fishing, fishing with barbless hooks, and hunting with bow and arrow as well as guns).

The capacity of wildlife resources is presently in slight excess of current use, which is carefully controlled by management agencies. However, there are conspicuous resources that are in short supply (table 30). Simply stated, the need for hunter-days is for all that can possibly be provided within the limitations of the resources.

LAND

For Agriculture

The land base for agriculture must be maintained to meet the food and fiber requirements of the future. It is recognized that by the year 2020, highway, urban, and recreation developments may utilize up to 60,000 acres of land that is presently used for agricultural and timber production. Land conversions for other purposes will be insignificant. These changes in land use will not seriously affect the agricultural industry if judgment is used in selecting the land for change.

For Timber

High value timber lands, denuded by past fires or other catastrophes, should be brought into timber production if they do not now support that crop. Other than these areas, it is not anticipated that additional land will be needed for timber production.

The requirements of other uses will continue to infringe on timber producing land. Additional recreation areas, highway and powerline construction and similar activities will diminish the area available for timber production. Also, the economics of growing timber will require land managers to concentrate their efforts on the best producing sites. In total, these factors will influence greater future timber production on less land area presently considered available for that purpose.

For Minerals

Land requirements for active operations of the mineral industry are nominal. Less than one-half of 1 percent of the total land area under study is being used for mining operations, but the return per unit of land used is high. Virtually all of the land held for mineral development, moreover, can be, and is, used for multiple purposes.

Continued access to timberland and to land needed for exploration is fundamental to continuing production and economic growth of the mineral industries, which, in turn, are an indispensable source of employment, personal income, and public revenue in the area.

It is a truism that minerals are where you find them. The best that geologists can do is to outline favorable areas where additional deposits may be reasonably expected, or where improved technologies may make mining of known deposits feasible. It would be unrealistic to say that any part of the land in the nine-county area is without mineral-producing potential, or that all mineral deposits of potential use to mankind are now a matter of record.

For Recreation

Needs for additional recreation land are expected to more than double by the year 2000 and increase nearly four times by 2020. In terms of acres, the greatest needs will be for extensively used recreation lands for hiking, riding, hunting, and sightseeing. In terms of percentage increase, however, the greater and more significant need will be for intensively developed lands for camping, picnicking, water sports developments, and part of the sightseeing demand.

The need for intensive areas will be the one that affects all sectors, has the greater influence on the economy, will involve more conflict of land uses, and will receive the greater publicity. The much-increased need for recreation land in the next 50 years will require some lands now managed primarily for other resources, notably timber and agriculture; however, within this period of time, these required land adjustments would not appear to be great enough to significantly reduce production in any other resource field. A number of specific problem situations, though, will require some controversial land-use decisions.

There are no true wild or wilderness-type areas in the Black Hills; however, there are some very fine semiwild areas in the Hills, Badlands, and Bear Lodge Mountains areas, and a lot of acreage in the plains that offer excellent opportunity for hunting, hiking, rock-collecting, and a general escape from man's hectic environment. There is an important need to identify, classify and retain several such areas, to maintain a balance of all types of "experience levels" of recreation opportunity and to avoid making the Black Hills one large outdoor recreation city. Some areas may require special classification and management to insure future protection.

For Fish and Wildlife

Most of the agencies exercising control over wildlife resources believe that present public ownership of land is adequate for the foreseeable future. There is a need, however, to provide access for hunting or fishing on private land. An additional need is for big game wintering areas on private land. There is a need for additional management that can and should be extended to the lands of nearly every wildlife population in the area. Accelerated multiple-use management on public lands is needed to enhance fish and wildlife habitat.

The principal needs for land and management for wildlife are outlined in table 40.

Table 40.—Need for additional land and/or improved management of land for fish and wildlife resources

Resources	Additional land	Additional management	Remarks
Deer 1/	X	X	Additional land requirements are for winter range in South Dakota.
Antelope		X	Generally, the antelope resource is considered to be in excellent condition.
Elk		X	Present population is considered to be maximum for the study area.
Bighorn sheep		X	Range extension desirable.
Mountain goat		X	Limited hunting may be needed.
Bison		X	Range improvement is needed.
Merriam's turkey		X	Present populations should respond strongly to management practices.
Pheasant		X	Involves providing winter and nesting cover.
Sharptail grouse		X	Involves improved grassland and protection of brush areas.
Ruffed grouse		X	Includes retention of deciduous growth.
Sage grouse		X	Includes retention of sagebrush.
Hungarian partridge			Small populations. No significant needs or problems.
Rabbit 2/		X	Hunting pressure not uniform.
Other 3/		X	Primarily concerns inadequate harvest.
Fur animals 4/		X	Includes protection of riparian vegetation.
Waterfowl	X	X	Management includes protection of nesting cover.
Fish	X	X	Land needed along stream courses for public fishing access. Additional management would include measures to improve watershed yields and reduce pollution of streams, particularly siltation.

1/ Includes both mule deer and white-tailed deer.
2/ Includes jackrabbits, cottontails.
3/ Includes fox, coyote, and bobcat.
4/ Includes mink, beaver, and muskrat.

Urban

In 1950 the Conservation Needs Inventory by the U. S. Department of Agriculture indicated that about 57,000 acres of land were within the corporate limits of towns and villages. In 1960 about 30 percent of this area was accounted for by towns with populations exceeding 2,000.

All indications are that most towns with populations under 2,000 will need a relatively small amount of additional land in the foreseeable future. New land requirements will be limited, primarily, to the larger towns. Acreage figures for 1940, 1950, and 1960 were obtained from nine of the larger towns. With the available population projections for these towns, it was possible to make some preliminary projections for land requirements. By 1980 these nine towns will require about 8,500 acres for expansion. From 1980 to 2000, 7,500 acres, and from 2000 to 2020, another 7,000 acres will be required. Based on these figures, it is estimated that about 80,000 acres will be needed for towns and villages in 2020, an increase of 23,000 acres over 1958.

WATER

For Agriculture

Private irrigation developments appropriated virtually all of the natural flows of streams in the area during the period of early settlement. This precluded further development of irrigation and created the need for additional storage provisions.

Construction of five dams and reservoirs in the Cheyenne Basin under Reclamation laws permitted irrigation development of about 69,000 acres of new land and supplemental water supply for about 9,000 acres.

Low streamflows during the period of 1959-61 caused severe water shortages to irrigated lands including those that were supplied from reservoir storage.

Further development of an appreciable irrigated acreage on the upper reaches of the Belle Fourche and Cheyenne Rivers would require large reservoirs capable of impounding infrequent floodflows for use during years of normal and below normal streamflow. Surplus flows of most Black Hills tributaries are relatively minor and, too, reservoirs with comparatively large carryover capacities would be needed to firm up any appreciable portion of the average annual flows for irrigation use.

Domestic water requirements for farm use are expected to decrease slightly from 1960 through 2020. Water use for each individual on farms is expected to double during this period, but the total farm population is projected to decrease from about 16,700 in 1960 to 7,700 in 2020. Water needs in 1960 and 2020 are estimated to be 933 acre-feet and 860 acre-feet, respectively.

With better livestock types, better range management, and more feed yard production, it is estimated that water requirements for livestock will double by 2020. The estimated water requirement for 1960 was 5,241 acre-feet, and by 2020, it will be 10,000 to 12,000 acre-feet.

For Municipalities and Industries

There will be a continuing need for developing additional sources of municipal and industrial water supplies as the population grows.

Population estimates for the area indicate that the total population will increase threefold over the next 50 years. It is estimated that 90 percent of the increase will occur in the nine major population centers.

Estimates of future municipal water requirements were made for the years 1980, 2000, and 2020 for the nine major population centers. The requirements are based upon standards of anticipated daily per capita water use at various population levels. The standards were derived from records of water use in representative South Dakota communities adjusted upward for anticipated increases in future use.

The following tabulation shows the estimated annual municipal and industrial water needs for the major population centers at selected future dates:

Annual municipal and industrial water needs
(millions of gallons) 1/

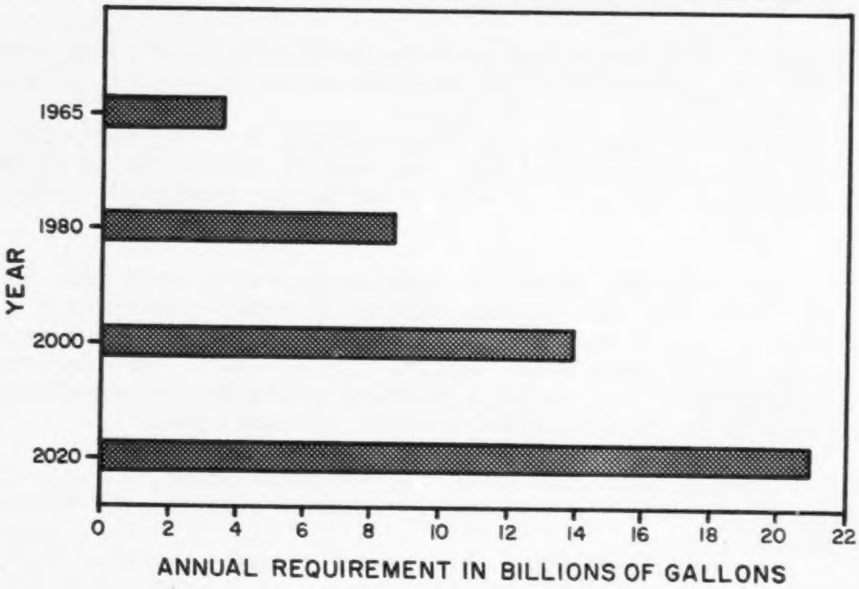
City	1960	1980	2000	2020
Belle Fourche	183	356	539	768
Custer	91	137	184	238
Deadwood	183	137	125	131
Hot Springs	183	337	435	588
Lead	219	337	362	435
Newcastle	136	450	697	1,015
Rapid City	1,642	6,025	10,378	15,972
Spearfish	146	351	539	785
Sturgis	219	435	658	958
Total	3,002	8,565	13,917	20,890

1/ To convert to acre-feet, multiply by 3.0689.

The above estimate does not allow for industries that are large users of water such as pulp mills, thermal powerplants, and wool-washing plants. Although demands of individual operators will change greatly, little overall change is anticipated in total demand for water in the mining industry.

The need for developing additional sources of water for the major population centers is evident when it is realized that by 1980 the total water requirement will more than double, and by the year 2020, it will be five times the present usage. This is illustrated in graph 19.

GRAPH 19. MUNICIPAL AND INDUSTRIAL WATER REQUIREMENTS FOR NINE MAJOR POPULATION CENTERS, BLACK HILLS AREA



For Recreation

Based on present (1965) opportunities and developments, the need for additional recreation waters can be expected to nearly double by 1980, triple by 2000, and increase about five times by 2020. Some present waters, however, are either underdeveloped, underpublicized, lack good access, or have other limitations that result in their not being used to full potential. If the recreational opportunities associated with these waters (primarily reservoirs) are fully developed, much of the near future demand can be satisfied. Full utilization would probably mean that the need for additional recreation waters would not become critical for another 10 to 15 years. Development of existing potentials will not eliminate unfulfilled demand, especially near population centers.

Undue concern with the exact needs for developing new recreation waters beyond the next 35 years is probably unnecessary, as it is expected that by the year 2000, all potential development will have been accomplished.

Several water-based activities compete for the same water areas. Soon, there will be a decided need to choose the water-sports activities that can and should be permitted on all popular recreation waters. At the same time, there will be increasingly greater competition for water for human, industrial, and agricultural use that will cause water-use conflicts and present alternatives for best utilization.

There will be a gradually increasing need to utilize, improve, and develop all recreation waters to full potential except those in the semiwild or isolated areas as described under "Lands".

For Fish and Wildlife

Cold-water fishing is the mainstay of the area's fishery; 84 percent of all anglers fish for trout. About 75 percent of all trout fishing now occurs on impounded waters. Current demand for cold-water fishing exceeds the base capacity of the fishery by about 73,000 fisherman-days, while less attractive warm-water fishing is moderately underutilized. Future demands will be greater due to increased population, more leisure time, improved transportation, and a prospering economy. To provide the additional fishing capacity needed to meet current and projected demands, suitable habitat must be restored and sustained. Additional aquatic habitat must be provided and more intensive management practiced.

Water quality improvements needed include: (1) Abating domestic and industrial pollution (photos 23, 24); (2) rehabilitating of some fish populations; (3) correcting improper watershed management practices associated with overgrazing and intensive farming (photo 25); (4) increasing waterflow in existing streams by accelerated programs of timber thinning (photos 27, 28); (5) augmenting streamflows by supplemental storage; and (6) minimizing mining and highway construction damage to streams (photos 26, 29, 30).

There is a need to increase the fishing waters by: (1) Reducing stream channelization; (2) installing stream improvement structures; (3) correcting instances of total diversion; (4) reducing the loss of stream miles to road and highway construction; (5) constructing more impoundments suitable for fishing; and (6) increasing streamflow by accelerated timber thinning.

Augmented streamflows for a few of the better cold-water streams are needed to maintain some high quality, "blue ribbon" trout fishing,

Photo 23

Pollution has degraded more than 200 stream miles in the area. Whitewood Creek is a "legal sewer" that carries domestic and mill waste and rubbish.

Photo 24. Sawmill wastes pollute Black Hills streams by the addition of tannic acid. Such wastes increase turbidity and curtail basic fish food production.

Photo 25. Silt from overgrazed valley bottoms (sheet erosion), road construction, and mill tailings pollutes the streams and even results in short-lived beaver dams such as this one shown here.

Photo 26. Rechanneling and diking on Rapid Creek to aid highway construction. This work shortened the stream gradient, promoted siltation, and severly damaged a significant amount of fish habitat on one of the better trout streams of the Black Hills.

Photo 27. A typical unthinned stand of ponderosa pine in the northern Hills. Such stands intercept a high percentage of precipitation, resulting in reduced streamflows. It is neither a productive forest nor a productive wildlife habitat. Thinning would promote the growth of timber and at the same time may increase watershed yield and wildlife habitat.

Photo 28. An older unthinned pine stand. Note the complete absence of vegetative understory necessary for wildlife.

Photo 29. Battle Creek near Keystone, South Dakota, is being squeezed between a public road and spoil piles of millfines of mica and feldspar. Bioassay tests with live rainbow fingerlings resulted in the death of more than two-thirds of the fish in a 72-hour period.

and for several of the lesser streams that could be very valuable for fishing with a moderate amount of supplemental water. Such flows are a nonconsumptive use of water that may also enhance public health, municipal and industrial water supply, irrigation needs, and recreation on downstream. Tables 41 and 42 indicate fishery problems and their location.

Other needs for fish as related to water include: (1) Providing better access opportunities along water courses; (2) revising outmoded or inadequate laws; and (3) improving fishery management practices (tables 41 and 42).

In general, water supplies for wildlife are adequate. However, in portions of the southern Hills, the absence of permanent water is believed to be limiting turkey numbers and distribution.

There is a need to strengthen or enact laws that will protect endangered species, unquestionably recognizing fish and wildlife conservation as a beneficial use of water, provide access to public resources, liberalize harvests of both game and rough species of fish and wildlife (including commercial use), and give legal status to water quality standards for fish and wildlife.

Table 41.—Stream fishery problems in the Black Hills area, 1965

South Dakota streams	Stream miles	Water quality	Water quantity	Inadequate laws	Access problems	Management problems
Rapid Creek	97	x	x	x	x	x
Spearfish Creek	19	x	x	x	x	x
Little Spearfish Creek	11	x	x	x		
Boxelder Creek	15	x	x			x
Beaver Creek	7	x	x			x
Iron Creek	6	x	x			x
Hop Creek	2	x	x			
Whitewood Creek	21	x		x		
Belle Fourche River	186	x		x		
Cheyenne River	204	x		x		
Jim Creek		x	x	x		
Gimlet Creek		x	x			
Bear Butte Creek		x	x			
False Bottom Creek			x			
Miller Creek			x			
Polo Creek			x			
Kirk Creek		x				
Wyoming streams						
Sand Creek	10		x		x	
Inyan Kara Creek	6		x			
Belle Fourche River	150		x	x		
Cabin Creek						x

Table 42.—Impoundment fishery problems in the Black Hills area, 1965

South Dakota impoundments	Surface acres	Water quality	Water quantity	Access problems	Management problems
Canyon Lake	37	x	x		
Reausaw Lake	4	x	x		
Farm & ranch pond	31,800			x	
Beaver ponds	Unknown				x
Wyoming impoundments					
Miller Lake			x		
Farm & ranch ponds	303			x	
Beaver ponds	11				x

Control

A comprehensive water pollution control study is needed to evaluate the existing water quality conditions and forecast the effects of future developments on the water of the area. This study would permit the establishment of a cooperative water management program which is needed to safeguard water quality for all the planned future legitimate water uses in the area.

There is significant need for inexpensive treatment processes to improve the quality of ground water from deep aquifers.

The flow in most of the streams varies greatly during the year and from year to year (graph 7). At present, natural streamflows are being fully utilized during the summer months on most streams, and, where reservoirs have been constructed to conserve water for resource development, the reservoir storage is being fully utilized.

Further development of the area's surface water will, for the most part, be dependent upon regulation of streamflow by additional reservoirs. On perennial streams, reservoirs could conserve streamflows during the winter months when demand for water is low as well as store runoff when streamflow exceeds the demand.

On intermittent streams, reservoir storage could conserve water during period of high streamflow for later release or use; however, reservoir capacities would be extremely large in comparison to the volume of water yielded on a sustained basis.

Damages from floods have caused hardships as well as financial burdens to the inhabitants of the Black Hills since settlement of the area. Reconnaissance data indicate about 308,000 acres is subject to flooding. A high percentage of this flooding is on grassland, but a significant part of the damage is on cropland and other areas, including urban areas.

At least 125 floods have occurred along the Cheyenne River and its tributaries since 1875. The frequency of floods in the Black Hills indicates a definite need for flood control measures.

Recharge to the Minnelusa and Pahasapa Formations is probably derived largely from surface streams that cross the outcrops of those formations in the Black Hills. No attempt has been made to date (1966) to induce recharge to the formations. However, if surface water were available, additional recharge to the Minnelusa and Pahasapa could be accomplished by dams on surface streams in the areas of outcrop. Further study is needed to determine if this kind of recharge is desirable or if water that presently enters these formations could be used more efficiently downstream.

Land management and treatment practices have a significant effect on ground-water recharge. The soil and subsurface rocks constitute the greatest reservoir available for conserving precipitation. Therefore, in most areas, on both public and private lands, there is a need to accelerate management and treatment practices.

MANAGEMENT AIDS

Fire Protection

One of the greatest threats to the natural resources of the Black Hills is wildfire. Fires, whether caused by lightning or by man, must be eliminated or reduced. Throughout the study area, many things are needed to increase the effectiveness of the fire control program. These needs are as follows:

1. A new and more effective approach to popularize fire prevention.
2. A continuous updating and improvement of fire presuppression facilities.
3. A more centrally located aerial tanker base.
4. Intensified study of weather modification to make full use of all elements in fire control.
5. Additional fire weather stations to fully measure fire weather conditions.
6. Fire protection on private lands not now covered under organized fire control. More intensive training for volunteer firefighting units.
7. Reduction or complete elimination of hazardous fuels, such as down logs, slash piles, and dead trees.
8. Measures to prevent fires from starting along roads in certain vulnerable areas.
9. Strengthened fire control measures in the Wyoming counties, and increased communications equipment at the county level.

Access

The need for access within the study area falls into two basic categories. First, there is a need of access for fire protection and control purposes, and for other administrative functions. Second, there is the need to provide access for increased resource use.

The need for new roads and improving existing ones is becoming more pressing as resource use in the Hills increases. New roads are needed that will provide access to undeveloped areas. Expansion of hiking and walking trails is also much needed.

Public lands and waters need to be identified on-the-ground, through surveying and marking, so that all people can participate in using the resources. Once the lands have been identified, access needs to be provided for all uses. There is specific need for easements across private land to reach public land and water. Access roads need to be of a quality that will permit public use under varying weather conditions. A further need is a map to identify all significant tracts of public land and water.

Photo 30. Lack of access is a primary obstacle to full utilization of the natural resources on both public and private lands. Posting of lands nullifies gains from improved habitat management.

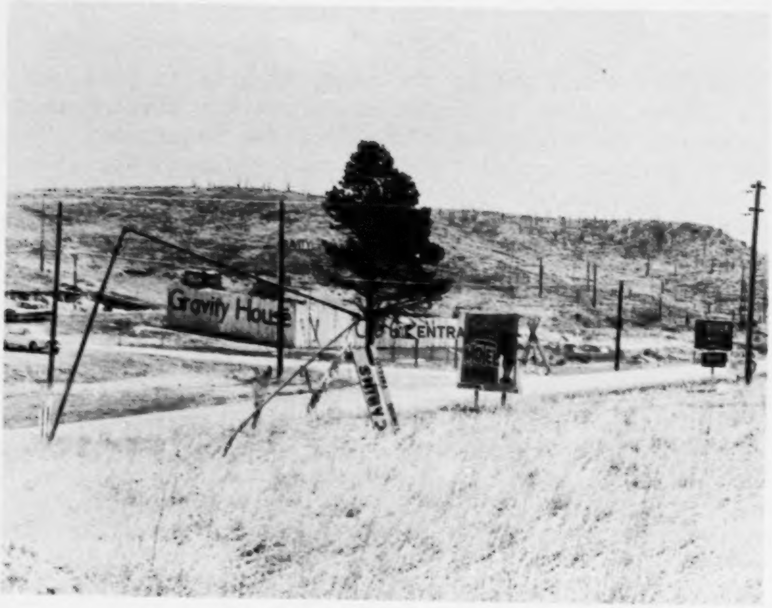


Photo 31. This scene shows the lack of, and need for, some form of roadside control in the Black Hills. Indiscriminate signing and lack of sign maintenance and architectural style create a poor impression on the visitor.

Photo 32. This type of littering occurs where inadequate facilities or public apathy exist. There is a great need in the Black Hills to remedy this situation.

Landownership Adjustments

There are continuing and pressing needs to adjust and realign public and private ownership boundaries to create more workable management units. Access need is an important consideration in all land exchanges, withdrawals, and sales involving public land.

Zoning, Planning, and Other Control

Minimum standards are needed for development in scenic areas, especially in the central Hills. In all regional, county and city planning and zoning, it will be necessary to consider the needs for comprehensive land use, adequate financing and additional legislation.

Roadside beauty and scenic vistas should be preserved in the Black Hills. To do this, early planning of the future transportation system must be undertaken. There is a need to control roadside intrusions such as junkyards and other eyesores. There is a need to promote acceptable standards in regard to size, shape, and color of roadside signs placed along access routes.

The increased tempo of land use may eliminate some scenic views for all time.

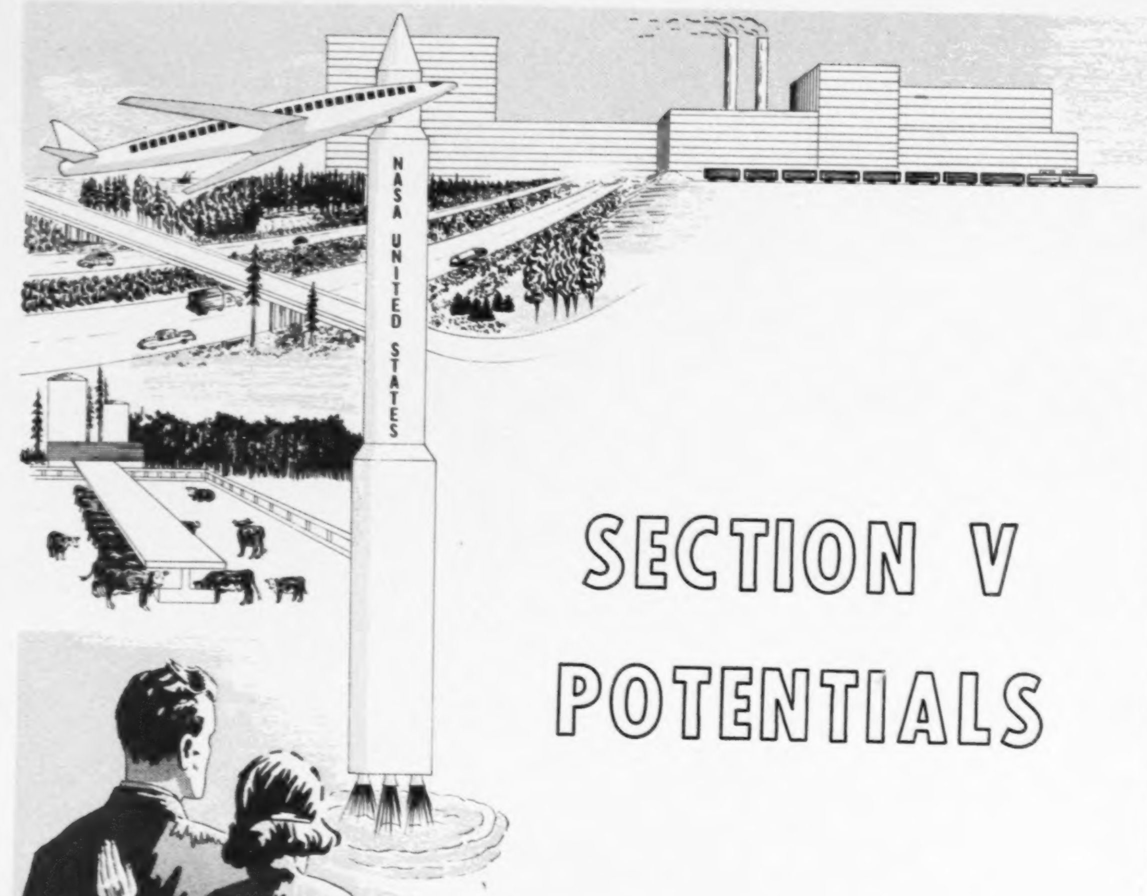
There is a need to plan road construction that will enhance or prevent damage to fish and wildlife values.

There is a need to strengthen legislation and the administration of regulations and policies governing the dumping of wastes into lakes and streams.

A more effective anti-litter campaign is needed.

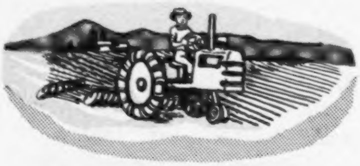
SECTION V

POTENTIALS



POTENTIAL UTILIZATION, DEVELOPMENT AND IMPROVED MANAGEMENT

This section of the report presents a discussion of the estimated extent to which many of the demands and needs for utilization, development and/or improved management of the resources can be met now and in the future.



AGRICULTURE

Production

Agriculture undoubtedly will continue to occupy more land in the Black Hills than any other industry. Farms and ranches now use approximately 83 percent of the total land area. These lands must furnish an increasing amount of agricultural produce for a growing population. In addition, their proper use and good management will have a beneficial effect on the quality and quantity of water used for domestic purposes, for fishing and other recreation, and on the propagation and harvest of wildlife. The industry will provide an important stabilizing influence to yearlong employment and the overall economic structure of the non-farm sector.

Projections discussed in section IV indicate that agricultural production in the Black Hills could triple by the year 2020. Because there is little opportunity for increasing the amount of land available to agriculture, other opportunities for realizing maximum yields should be seized. The most promising involve irrigating new areas, providing more water for inadequately irrigated areas, and applying improved technology and better management.

Some opportunity exists to increase the amount of cropland for production of cereal grain to meet projected needs shown in table 35. Most of this cropland would come out of land presently used for grazing or hay. There are more than two and one-half million acres of grassland in Land Capability Classes II to IV. About 4 percent of this amount is Class II land with minor conservation problems. The balance would require extensive conservation treatment to control erosion and other problems.

Irrigation

Reconnaissance land classification surveys in the area indicate that there is about 100,000 acres of land suitable for irrigation. Most of the land (80 to 90 percent) is in small scattered tracts ranging from a few feet to 50 feet above area streams; the remainder is on high terraces. Sixty percent of the suitable land is along tributaries of the Cheyenne and Belle Fourche Rivers and 40 percent is along the main stem of the two rivers.

Streamflow records indicate that there might be sufficient water to irrigate about one-third of the suitable land, if all of the surplus water were used for this purpose.

Studies indicate that about 4,500 acres suitable for irrigation on the bottom lands of the lower Belle Fourche River below the Belle Fourche Project could be developed. However, suitability of the water for sustained irrigation is questionable. Streamflow in most years would be sufficient. Without reservoir storage, however, there would be severe water shortages during infrequent but critical years of low streamflow.

Reservoir sites suitable for economical development are not available on the Belle Fourche River. The most favorable offstream site exists near the mouth of Four Mile Creek. During the spring and early summer, water could be pumped from the river into a reservoir at this site. Releases from the reservoir during periods of low streamflow could serve 80 percent of the irrigable area. The rest of the area could be irrigated from natural streamflows. Pollution abatement of water in the lower Belle Fourche River warrants special study. Suitability of this water for sustained irrigation is questionable, and development should not be considered until the water-quality question is resolved.

It is estimated there is adequate water to develop irrigation on approximately 31,500 acres along tributary streams. Water for these lands could be supplied by reservoir construction and by diverting streamflows now lost to limestone sinks. The best potentials for small projects appear to be on Boxelder, Elk, Rapid, Battle, and Beaver Creeks in South Dakota, and Inyan Kara, Arch, and Cabin Creeks in Wyoming.

There is also an opportunity to make greater use of uncontrolled runoff in area streams through water spreading on hay and pasture land for winter livestock feed. There is about 230,500 acres of land suitable for water spreading.

Improved Technology

Advanced technology offers the best opportunity to increase production. Better crop varieties, better livestock types, and more efficient farming methods will all contribute toward meeting more of the production demands of the future.

The rate at which farmers and ranchers adopt and use new technological advances will have a major effect on increased production. From 1910 to 1950, estimated agricultural outputs increased 75 percent. Forty percent of the increase was due to adoption of technological improvements.

Studies by the U. S. Department of Agriculture and the State agricultural universities indicate improved technology can increase crop yields from 15 to 20 percent by 1980, and from 40 to 50 percent by the year 2020. This potential increase applies to both irrigated yields and dryland production. By 1980, improved technologies should increase yields of corn one-fifth and hay one-fourth. By 2020, the average yield on irrigated land is expected to increase 40 to 50 percent.

Management

Future demand will determine the relative production requirements for various crops. Producers will have to diversify their crops, however, to achieve maximum stability in the agricultural industry.

Present capacity for grazing domestic livestock can be increased 25 to 50 percent with increased use of fencing, seeding and water developments. This will help meet present unfulfilled demand for grazing. More intensive management and crop diversification also will play important roles in expanding livestock production.

Utilization

Nonfarm as well as farm income can be increased considerably by establishing new or expanding existing processing plants for agricultural products. Studies have shown that local processing plants would reduce significantly the transportation costs for many finished products now being imported. Increased crop and animal production will create a potential for local packing plants, dairy product plants, poultry processing plants, forage and grain feed mills (including dehydrating and pelleting plants), and flour mills.

Soil and Water Conservation

Technical assistance on both private and public land must be accelerated to plan and apply the required conservation measures needed to maintain the land resource and help provide food production for a growing population. At present rates it likely will take up to 75 years to get public acceptance and adequate conservation on the land. Acceleration is needed to accomplish the job in the next 20 to 50 years. To meet this goal, technical assistance will have to be doubled in the next 5 to 10 years.

To fulfill conservation objectives increased participation in the cost-sharing program should be encouraged. Greater acceleration of conservation measures on the land would result if group and community projects could also be developed. These would include projects for erosion and sediment damage reduction, flood prevention, and water management projects. Higher cost-share rates will encourage application of the enduring type conservation practices such as terraces, waterways and diversions. It would encourage seeding of low capability cropland into permanent vegetative cover, and accelerate application of wildlife and recreation practices. Where public lands are leased to ranchers, the installation of conservation practices fosters a feeling of sharing, thus increasing the rancher's interest in properly maintaining the practices.

Credit

Use of credit probably will triple in the future if resource development follows the expected pattern. Many resource development projects, such as irrigation and flood control, involve high risks and require long-term credit at low interest rates. Present Federal credit programs have the potential to meet future needs for borrowers who cannot obtain credit from private sources. The Farmers Home Administration loan programs are well oriented to meet the potential credit problems of family-sized farms and ranches, rural associations, cooperatives and rural communities.

Conclusions

For the agricultural industry to fulfill indicated needs and meet the future potential projected requirements for food and fiber, the following specific conclusions become apparent:

1. Land resource projects, including irrigation, watershed, and waterspreading projects, should be developed that will provide direct benefits to the agricultural industry and multipurpose benefits to other natural resource functions.

2. A standard soil survey should be completed for the entire area within a period of five years for use in land-use planning, zoning, and resource developments.

3. Technical, cost-sharing, and credit assistance should be accelerated to adequately plan and carry out needed land-use adjustments and soil and water conservation treatment practices.

4. Land used for livestock grazing should be managed so as to increase forage production to meet the projected needs for meat products. Principal management needs include distribution of livestock, reseeding, and control of noxious weeds.

5. A rangeland and agricultural watershed research center should be established in the area to provide basic information on how the limited water and other resources of the region might be more effectively and efficiently converted to grass and forage for livestock use and how the limited water supplies of these range and agricultural lands can be used most wisely for municipal, industrial, livestock, and other uses.

6. Other agricultural research programs dealing with development of new crop varieties, improved soil and water management and cultural practices, use of fertilizers, livestock and range management, reseeding, and control of noxious weeds should be accelerated. Economic research studies regarding processing and transportation costs of crop and livestock products also should be accelerated.

7. Agricultural industries that could process raw products locally should be developed. Processing of local products would reduce transportation costs and thus improve the general economy of the area.

TIMBER

The quantity and quality of timber ultimately produced within the Black Hills area will largely depend on the timber management practices applied. Both the intensity of sound management practices and the extent of the area receiving intensive treatment will materially affect production. Obviously, maximum timber benefits would accrue only if management of this resource were made paramount.

Where timber exists as the dominant natural cover, its management will largely determine benefits that can be derived from use of other dependent, associated resources. Manipulation of timber cover is known to directly, and indirectly, affect the quantity and quality of streamflow. Presence, absence, or condition of timber affects wildlife distribution and populations; it also influences the grazing patterns of domestic livestock. Without the beauty of its timber cover, the lure of the Black Hills to the recreationist would be greatly diminished. A sound timber management program is prerequisite to the fulfillment of the many potentials of the area.

Maximum overall economic gain can be realized only through multiple-use management. Under this concept, no single activity or resource use can operate freely to the exclusion of all others. Restrictions on full development undoubtedly will be necessary to achieve a balanced maximum sustained use of all resources and activities. Any such restrictions will be compatible with management for wood production as long as sufficient growing stock can be maintained and harvested to provide an economic base for industry. It is not likely that the need to manage timber for its wood production potential will be appreciably reduced because of incompatibility with other resources or activities.

Timber Stand Improvement

Measures, such as harvest cutting, thinning, and tree planting, regulate the use of growing space and are directed toward quantity wood production. They can eventually provide a base for sustained annual harvests well above the present allowable cut. The key to realizing this potential is the development of a marketing capacity which will utilize the products cut.

A true evaluation of the potential for wood production must consider the application of those quality improvement measures that now hold at least some promise for the future. Those stands, and those trees within the stand, which indicate a potential to produce enough clear wood by the time they are cut to repay the cost, should be pruned, but they must first be placed in a good growing condition by thinning. Direct improvement of stem quality by pruning is expensive, hand-labor work. Increased labor costs have almost precluded pruning except in the very best of stands. More pruning activities would be justified if labor costs became less significant or if plywood or utility pole markets expanded.

Research into timber-water relationships is necessary to realize the potential maximum water yield. A well-managed, properly-spaced timber stand with an open crown canopy is not only healthier and more vigorous but it lets a greater volume of precipitation reach the ground than an overstocked stand. The smaller number of trees per acre may use less water for transpiration. The net result of these two phenomena may be increased streamflow. Because water yield throughout the area is becoming increasingly important, its relationship to timber stands and their management cannot be over-emphasized.

Another indirect benefit of improved timber management relates to the range and wildlife resources. Thinning timber stands increases grass and browse growth underneath. Cutting patterns, cutting intensities and tree species can be varied to enhance both resources. Full potential of the range and wildlife resources (like the water resource) cannot be realized without first placing the dominant vegetative cover, timber, in a well-managed condition.

Utilization

The maximum potential for sustained wood production can be realized through a continuous cutting program that meets the annual allowable cut. It has been noted that a substantial difference now exists between timber growth and utilization for both sawtimber and roundwood. Nearly one-third of the allowable sawtimber cut is not now being harvested. The timber growing potential depends on the degree to which stands are maintained at optimum stocking levels. Old growth must be periodically removed and young stands thinned to maintain optimum growth and stocking levels.

Marketing trends for forest products indicate per capita plywood consumption is increasing at a rapid rate; on the other hand, per capita lumber consumption is decreasing. In fact, most markets for low-grade lumber already have been taken over by various panel products, notably plywood. Plywood offers lower in-place costs for sheathing, subflooring, forming, and similar construction uses. These are the same uses upon which lower common grades of lumber depend, and ponderosa pine sawtimber in the Black Hills produces predominantly these lower grades. On this basis, it appears that a plywood manufacturing facility has the greatest potential for closing the gap between actual and allowable cut.

A plywood plant located at Rapid City, for example, would have a transportation rate advantage by either truck or rail to a population of over five million people in South Dakota and surrounding States. Nationally, the per capita consumption of softwood plywood is about 50 square feet annually. This indicates a potential market of 250 million square feet (of all grades) or about four times the capacity of a local plywood mill cutting 20 to 25 million board feet annually. Black Hills timber would be manufactured primarily into structural or sheathing grades, with a limited amount of high-grade knotty pine paneling.

Normal expansion and increased efficiency in the existing sawmill industry will help close the gap between utilization and allowable cut. However, its effect alone will be much too slow to meet the urgent needs ahead, and any lag in the removal of sawtimber as it matures will cause a corresponding delay in reaching the intensively managed condition absolutely essential to the maximum production of wood fiber. Sawmilling facilities of the future will have to be highly efficient and specialized, and maintain firm markets for their products, just to stay in business.

The manufacture of particle board has potential for the area. While this process is best suited for utilizing sawmill residue, it also could utilize much of the larger, low-quality material. This would permit sawmills to increase efficiency by concentrating production on higher quality logs.

Less than 25 percent of the estimated allowable cut for roundwood is being utilized. Although natural expansion of the post and pole industry will demand an increasing share of the available resource, pulpwood consumption in the long run apparently has the greater potential for total use.

If current marketing practices continue, expansion of the pulpwood industry will be determined by demand from the Great Lakes States' pulp mills. Growth has been dependent upon current needs of two or three mills purchasing from the Black Hills. Railroads directly link the Hills to Great Lakes area plants with a pulping capacity of over four million cords annually. Freight rates, in some instances, are cheaper from the Hills to Lake States mills than from locations within the same Lake State. The full potential is now limited by a reluctance to make certain technical mill modifications permitting the use of ponderosa pine, and by an unawareness by some producers of the availability of Black Hills timber.

Present marketing practices result in the export of local pulpwood for processing in other areas. Ultimately, local pulping facilities should be devised. This potential is dependent either on the development of milling techniques using much smaller water volumes than are now required or establishment of a mill on the Missouri River.

Continued expansion of production and development of maximum potential of the area will require a more integrated industry than exists today. Normally, a single stand of timber contains a variety of potential products. These should be recovered during a single harvest. Repeated entry for each product group causes sustained land disturbance and excess damage to the residual stand. Management costs increase and reduce net returns.

Greater mechanization of the woods operation will become increasingly essential since numbers of skilled woodsworkers are becoming fewer. Job opportunities can be enhanced by organizing operations to provide yearlong employment. While favorable rail rates have permitted development of a pulpwood industry, shortages of freight cars often seriously hamper expansion.

Conclusions

In order to realize the maximum potential of forest lands, additional activities involving multi-use management and promotion of the timber industry itself should be undertaken. These include:

1. Accelerating precommercial thinning.

2. Prompt reforestation of lands best suited to commercial timber production.

3. Inventorying the timber resources on State and private lands.

4. Enacting forest insect control legislation which would provide the State of South Dakota with the means for controlling insect outbreaks on private lands.

5. Accelerating technical assistance by State Foresters to meet management, utilization, and marketing needs of private timber landowners and industry.

6. Expanding forest research to include studies in utilization and marketing and in tree improvement aimed at the development of a quality pine hybrid.

MINERALS

From the standpoint of potential utilization, the mineral resources of the Black Hills area fall into three categories. These are (1) commodities such as bentonite, rock, common clay and shale, iron, gypsum, sand and gravel available in large or nearly limitless reserves for which expanded production awaits only the development of new uses or the expansion of existing markets; (2) minerals such as gold, the pegmatite minerals, uranium, and ceramic-grade clay of limited known reserves but for which experience has shown that exploration will yield new discoveries when economic conditions warrant, or when more efficient extraction methods are developed; and (3) minerals such as silver, lead, zinc, tin, molybdenum and vanadium, which have been produced in minor quantities and for which prospects for greatly increased production are not bright. These observations are subject to the reservation that new developments in mineral exploration methods may lead to the discovery of deeply buried deposits, the search for which is not now feasible.

A commodity-by-commodity analysis of the known mineral potentials and estimates of resources are shown in table 43. More thorough discussions of the potential of several of these minerals may be found in the following reports prepared respectively for Senators McGovern and McGee:

U. S. Congress, Senate Committee on Interior and Insular Affairs, 1964, Mineral and Water Resources of South Dakota: U. S. 88th Cong., 2nd sess., 295 pp.

U. S. Congress, 1960, Mineral and Water Resources of Wyoming: U. S. 86th Cong., 2nd sess., 40 pp.

These will be referred to in the next few pages as the South Dakota and Wyoming Reports.

Table 43.—Summary of nine-county mineral resources and estimate of production potential (Petrick, Bureau of Mines, October 1965, p.5)

Commodity	1965	1980	2000	2020
Fuels				
Uranium and thorium	A			
Natural gas	A	B		
Petroleum	A			
Coal	n			
Metals				
Gold	A	A		
Silver	*			
Tungsten	*			
Molybdenum	a			
Vanadium	A			
Copper	*			
Lead and zinc	*			
Iron	a	a	A	A
Minerals				
Mica	a	A		
Feldspar	A	A		
Clay	*			
Limestone	*			
Gypsum	a	a		
Beryllium	a			
Lithium	a	A		
Manganese	b			
Salt	a	a	a	

A. Resources are estimated sufficient to meet all foreseeable demands for a 20-year interval.

a. Resources are uneconomic, but estimated to be of sufficient size to support a mineral industry for some future 20-year period.

B. Resources are estimated insufficient to meet all foreseeable demands for a 20-year period.

b. Resources are uneconomic, and estimated insufficient to support a mineral industry for some 20-year future period.

n. Negligible resources.

* Resource present but data are insufficient to classify further.

Gold and Silver

Gold reserves are imperfectly known because it is impractical to determine deep or remote reserves until mining of existing ores make them accessible. It seems likely that mining costs will overtake the fixed price of gold and cause mining to be stopped before the most deeply buried ore has been reached. Homestake Mining Company has consistently maintained a 10-year reserve at the existing rate of production. Judging from the value of ores mined from the Deadwood Formation prior to the Federal shutdown order in 1942, there are also large but undetermined tonnages of gold-bearing rock in the Maitland and Trojan areas that average between five and eight dollars per ton at the current price of gold.

Most Black Hills silver production is a byproduct of gold refining. It is conceivable that further increase in the price of silver might justify reopening of old lead-silver properties at such localities as Galena and Carbonate.

Petroleum and Natural Gas

Although reserves in existing fields are fairly well known for Niobrara, Weston, and Crook Counties, a still greater potential may lie in discoveries yet to be made. Geological indications are that individual fields will continue to be small and that discoveries will more or less offset production. The petroleum industry thus may continue at its present pace for many years.

It is not anticipated that large gas reserves will be encountered. The area will continue to be dependent upon outside sources for a major share of its industrial and domestic gas requirements.

Bentonite

Estimation of bentonite reserves depends upon the depth of overburden that can be removed economically at any given time, and upon whether only the yellow, swelling, near-surface clays are considered, or whether the more-deeply buried, blue, low-swelling clays are also included.

The only published figures of reserves in the Black Hills area are those for the Clay Spur bed in the Clay Spur district, where the amount present is estimated to be "two million tons or less of commercial bentonite." Much more extensive bentonite deposits are present in the northern Hills.

Very large potential resources of bentonite, which are of little present value, include (1) deposits in the Clay Spur and Newcastle beds that lack the properties of bentonite now in demand; (2) deposits under excessive overburden; and (3) bentonite of low grade, insofar as present uses are concerned, occurring in beds other than the Clay Spur and

Newcastle beds. Besides the Clay Spur and northern Black Hills districts, large bentonite deposits also occur south of the Hills, and relatively small ones are present on the east flank of these mountains. The potential resources of bentonite in the Black Hills have not been invesitgated adequately. The total amount present is certainly as much as 100 million tons and may actually be several times this figure. Large tonnages of this clay may eventually be used for purposes quite different from those for which most Black Hills bentonite is now sold.

There is a tendency among bentonite producers to increase their total productive capacity by building new plants in other parts of Wyoming where extensive reserves are known. It seems unlikely in the foreseeable future that Black Hills output will exceed the present capacity of existing mills.

Some bentonite strip-mining pits can be reclaimed by leveling and reseeding. A major problem encountered is the difficulty of establishing any vegetative cover on the very poor soil that remains after stripping operations. Top soil could be stockpiled prior to the mining, but even then revegetation would be marginal and costly.

Uranium and Vanadium

The larger known uranium reserves of the Black Hills will be mined out prior to the end of 1966. There has been little exploration since the 1958 cutoff order of the Atomic Energy Commission. It is reasonable to assume that other deposits may be found by further exploration of the outcrop areas, and also in areas where the ore-bearing sandstones may be buried.

The only vanadium produced in the Black Hills has been a byproduct of uranium production. Presumably, additional vanadium will be recovered when and if uranium mining is resumed.

Stone

The Minnekahta Limestone outcrop forms a ridge that completely encircles the Black Hills. It fails to appear only in Niobrara County. The outcrop varies in width from 200 feet to nearly three miles, and the formation averages 40 feet in thickness. Assuming an outcrop width of 1,000 feet, the formation contains 3-1/3 billion tons of limestone free of appreciable overburden and lying generally above the water table. This is a 1,200- to 1,500-year supply at the present rate of consumption.

The Pahasapa Formation has an outcrop area within the Black Hills of about 580 square miles. Total thickness of the formation ranges from 300 feet in the southern Hills to 660 feet in Spearfish Canyon. Assuming that the average thickness of outcrop is 264 feet (1/20th miles), there is a volume of 29 cubic miles of Pahasapa under the outcrop area. The potential of the formation is not as great in the limestone as in the dolomite and highly dolomitic limestone beds within it. Individual dolomite beds over 100 feet in thickness are known.

In addition to limestone and dolomite, there are extensive reserves of quartzite, prophyry, and other abrasion-resistant rocks suitable for road metal, ballast, and riprap.

Sand and Gravel ·

Huge reserves of sand and gravel, suitable for road construction and similar uses, are available. The largest deposits are found outside of the Hills proper, in the broad valleys of present-day streams, and on high, interstream terraces. A generalized map showing the distribution of gravels within South Dakota is contained in the South Dakota Report. Most of these gravels are alkali reactive.

Sands suitable for masonry use are extensively distributed along the Cheyenne River. As available sources are exhausted, new, less accessible deposits will be developed.

Silica sand, which in the past has been used as a fracturing medium in oil wells, is available from the Deadwood Formation in the Ditch Creek area, Pennington County. Reserves are known to be large.

Sands suitable for glass manufacture and as molding sand are present in the Minnelusa Formation in virtually limitless quantities.

Pegmatite Minerals

Black Hills reserves of feldspar, mica, beryl, and lithium minerals exceed total past production. These important minerals stand as a reserve against the time when demands cannot be met by imports, or by domestic ores that now can be mined and milled more economically than those in the Hills.

In an inventory of known reserves in the Black Hills of South Dakota, the U. S. Geological Survey has presented the following tonnage estimates (South Dakota Report, pages 129-131):

Lithium.--Fifteen deposits are known that contain more than 0.4 percent lithium oxide (Li_2O), with an estimated total of 21,000 tons. One percent Li_2O is the approximate cutoff point below which pegmatites cannot be mined for lithium minerals alone. Some 12,000 tons of Li_2O is estimated to occur in deposits of this concentration.

Beryl.--Twenty-six deposits are known that contain more than 100 tons each of beryl, and have a grade exceeding 0.2 percent. These are estimated to contain 17,400 tons of beryl. Applying the cutoff of one percent below which pegmatites cannot be mined for beryl alone, this figure is reduced to 3,500 tons of beryl.

Feldspar.--Pegmatites containing 30 to 50 percent potash feldspar probably have a reserve equal to past production (1.4 million long tons).

Mica.--Large but unestimated reserves of scrap mica are present in known pegmatites. No appreciable reserves of sheet mica are known; future production depends upon additional discoveries. Judging by past performance, such deposits would be discovered in case of a national emergency.

Gypsum

Discontinuous beds of gypsum in and just above the Spearfish Formation crop out intermittently around the Black Hills. These lenses are generally less than 10 feet in thickness, though local thicknesses of from 30 to 40 feet have been reported. Outcrops are narrow, and the beds soon dip beneath overlying strata. Cox and Bowles (South Dakota Report, p. 135) conclude that "the Spearfish and Gypsum Springs formations contain large reserves of gypsum that are adaptable to exploitation by surface mining," but they give no tonnage estimates.

Gypsum in beds 25 to 40 feet thick occurs in the Minnelusa Formation in T52N, R61W, Crook County, Wyoming. It has been mined only for fabrication into art objects.

Iron

Extensive iron-ore deposits in the Black Hills await development when economic conditions are favorable. The figures on the following page show inferred reserves based on preliminary studies by the Bureau of Mines.

An analysis of the taconite potential of the area has been published by the Bureau of Mines (Harrer). It has been stated that adequate limestone, dolomite, bentonite, fuel, and power are available to support a mining, beneficiating, and pelletizing facility. Estimated initial cost of a minimal one-million-ton operation is given as $26 million. Harrer anticipates that pellets would be shipped to blast furnaces outside the State. In conclusion, Harrer states: "Activation of a taconite enterprise in South Dakota is a long-range venture dependent upon the answers to many exploration, beneficiation, economic, and financial problems. Public problems involved will include the acquisition of Federal mineral land patents or some other form of agreement, water pollution control and conservation, and the location of the taconite in the general forest and recreation area of the Black Hills."

Ore type and area	Grade		Short tons
Taconite (specularite-martite-magnetite) ore			
Nemo District, Lawrence County			
	Material containing 20-43 percent iron, avg. 29 percent		500,000,000
Nematite-limonite ores			
Two Bit Gulch, Lawrence County			
	Material containing 20-40 percent iron	100,000	
Iron Mountain area, Custer-Pennington Counties			
	Material containing 30-60 percent iron	750,000	
Strawberry Ridge, Hayward, Bobcat Gulch			
	Material containing 35-45 percent iron	100,000	
Total, hematite-limonite ores			950,000
Bog iron (limonite-goethite-turgite) ores			
Rochford-Nahant areas, Lawrence-Pennington Counties			
	Material containing 25-56 percent iron		500,000
Total tonnage (inferred) all iron ores			501,450,000

Coal

Coalbeds remaining in the nine-county area are generally less than five feet in thickness, and have a high ratio of overburden to coal thickness. Total original reserves, as calculated by the U. S. Geological Survey, total 352 million tons (table 44). While this figure appears large, it represents only one-half of one percent of the reserves in adjacent Campbell County (62,219 million tons) where beds of subbituminous coal locally exceed 100 feet in thickness, and where overburden-to-coal ratio may be less than one to one. The only conceivable potential lies in the bituminous coking coal remaining in the now abandoned Cambria area, Weston County.

Minor Minerals

The total tin reserve is estimated at less than 1,000 tons, mostly in pegmatites and quartz veins with a grade of one-half to one percent.

A small production of tungsten would be expected from the Deadwood, Lead, Hill City, and Spokane areas in case of a national emergency. The deposits are not of the size or concentration to be considered commercial under normal market conditions.

The recently discovered molybdenum deposits in basal Chadron beds, Indian Creek, west of Scenic, Pennington County, contain an undetermined tonnage of molybdenum-bearing sandstone. Investigations have not proceeded to the point where tonnage or concentration estimates can be made.

Table 44.—Original coal reserves (In thousands of short tons, in beds $2\frac{1}{2}$ to 5 feet thick unless otherwise noted)

County	Area		Lignite	Subbituminous	Bituminous
Meade	Stoneville	T9N,R12E	1,380		
Fall River	Edgemont	T7S,R2E			6.8
		T9S,R3E			4.1
Weston	15 townships total			1/ 285,370	2/ 39,940
Niobrara		T40N,R66W		560	
		T34N,R67W		12,530	
		T41N,R67W		1,220	
Crook	Aladdin	T54N,R61W			590
	Sundance	T51N,R64W			560
	Moorcroft	T49N,R68W		8,640	
Total, all coals			1,380	308,320	42,100.9

1/ Including 36,310,000 tons in beds 5 to 10 feet thick.
2/ Bituminous coal in 6 townships only.

Areas where zinc and/or lead mineralization occurs are well defined. These include the Spruce Gulch, Galena, Spokane, Silver City, Carbonate, and Calaboogia areas (map 8). Although known high-grade deposits in these camps have been worked out, undetermined reserves of low-grade ore remain and, particularly at Galena, it is reasonable to believe that subtantial ore bodies remain to be found by systematic prospecting.

Small pockets of manganese ores occur in Paleozoic limestone and in Precambrian and Tertiary rocks in the Black Hills and Bear Lodge Mountains. Experience during World War II indicates that small tonnages can be produced when buying standards are lowered to about 30 percent MnO_2.

Deposits of low-grade talc have been reported in Lawrence County. At present, these are not competitive with beds of higher grade that are closer to markets.

Conclusions

Consideration of mineral resource potentials in the Black Hills area leads to the following principal conclusions:

1. A simple method of mining bog iron should be developed in conformance with State water requirements.

2. A study should be made of taconite development to delineate the problems that mining and concentrating this major resource may introduce, and to establish methods to minimize or eliminate them before mining starts.

3. An economic process should be developed to upgrade nonswelling bentonite of either the blue or yellow type, thus increasing substantially the commercial reserves.

4. Economic, regional, and experimental geology studies of minerals and fuels, including geologic mapping, geochemical and geophysical research, and development of new exploration techniques and tools to find concealed deposits, should be expanded.

5. Technologic and economic research should be initiated to develop new uses and expanded markets, particularly for the large reserves of such minerals as bentonite, common clay and shale, gypsum, rock, and sand and gravel.

6. Mining and extraction research should be encouraged to develop more efficient methods of recovering from limited known reserves of such commodities as gold, uranium, ceramic-grade clay, and the pegmatite minerals.

RECREATION

Recreation will be the major industry of the future for the Black Hills area. From the recreation it can supply to many people, the area will receive greater economic benefit than from any other resource activity. With wise planning and use, the area has the potential to meet most of the needs of the year 2020 and still not be near the visitor-saturation or resource-exhaustion point. This will mean, however, that the area will have to promote, capitalize, and largely depend on its "land-based" recreation assets, especially as the year 2000 approaches.

The Public Sector

Improved management.--Improved management techniques will greatly assist the area in properly developing its recreation potential. Coordination with the private sector and between public agencies could be improved through formation of a coordinating group with State, local, Federal and private membership. Information and plans could be exchanged and overall development policies and goals correlated.

Betterment of many recreation areas can be achieved through scheduled maintenance, installation of more heavy-duty facilities at all family units, and greater use of traffic barriers, plantings, paving materials, and replacement topsoil. Research to determine the tolerance of vegetation and facilities to heavy use, and collection of more accurate statistics on visitation and visitor preference would be very useful. Aerial photography is but one new data collection method that can be used.

To meet the need for better financing of State and local recreation programs, additional funds might be provided through bond issues, special taxes, user fees, greater general fund appropriations, and full use of Federal matching fund programs. In the future, State and local government should provide a greater percentage of the area's recreation facilities.

Land-based recreation.--Potentially, the area has sufficient land-based recreation resources on public lands to meet the needs of the year 2020 in sightseeing, camping, hiking, and picnicking. In addition, needs for horseback riding, attending outdoor drama and concerts, and "outdoor games and sports" can be handled. Future hunting opportunities will become limited. It is difficult to predict if all winter sports needs will be met, as the snowfall and climate are limiting factors. Potentials are discussed below by activity groupings.

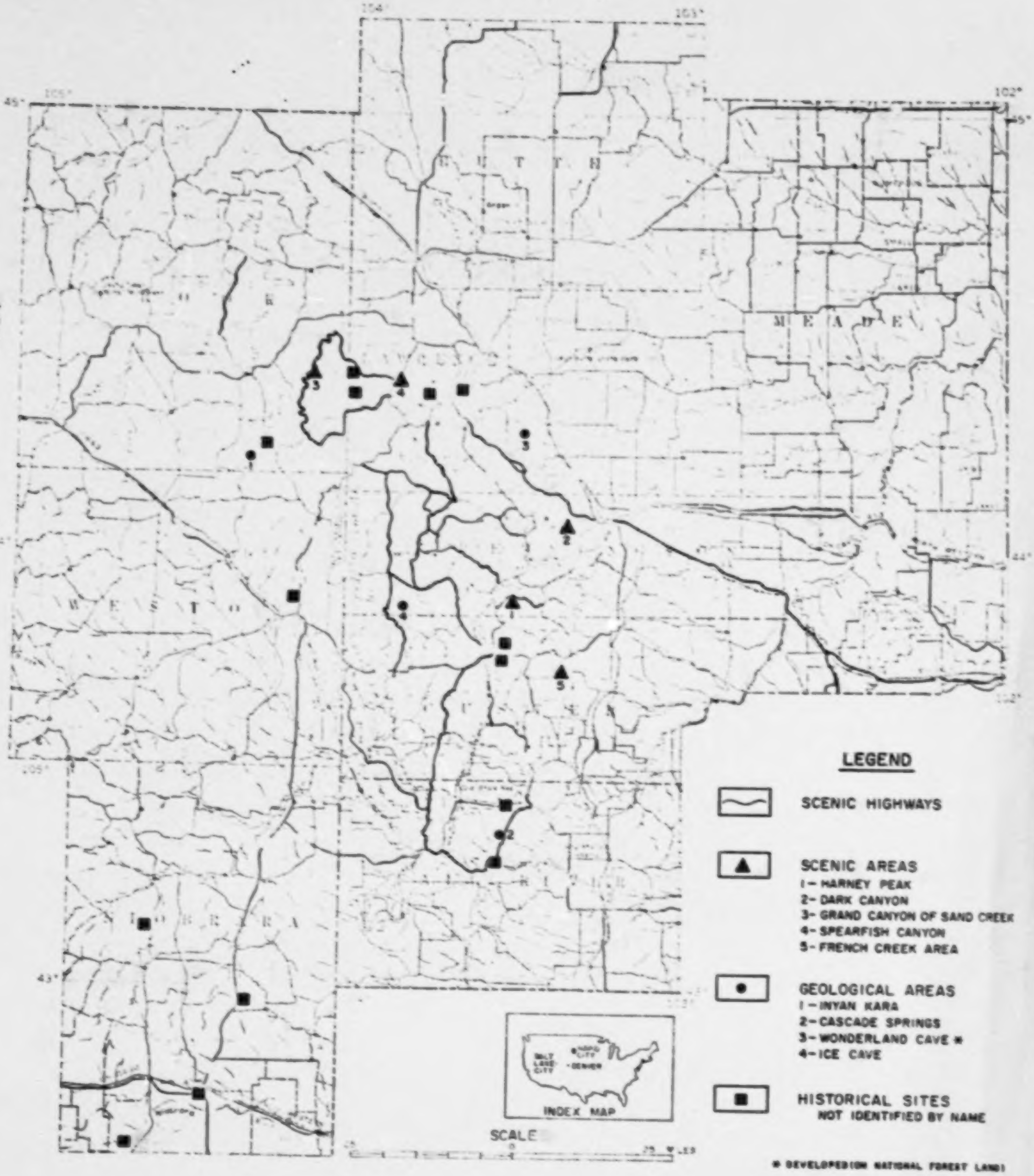
To help meet the needs for sightseeing, hiking, camping, and picnicking, lightly developed areas should be more fully developed. Before 1980, major emphasis should be placed on providing better access to and development of the Bear Lodge Mountains and the southern and, especially, the western Hills.

The potential for developing additional natural attractions for handling sightseeing demand is good. Most of the outstanding natural attractions are in the Black Hills National Forest and will be developed by the Forest Service. Several of these areas will be kept partially or wholly in the semiwild state. The development potentials for the primary areas are listed below (map 15).

Harney Peak.--This is the highest peak in the Black Hills. The peak should be made easily accessible and developed with a visitor center, trails, overlooks, and limited camp and picnic sites, while retaining semiwild nature of surrounding scenic area. Development is needed now.

French Creek.--An outstanding semiwild area in a scenic portion of Custer State Park. It should be developed for hiking, riding, and wilderness camping as soon as possible.

Dark Canyon.--This scenic canyon should be developed with trails and associated camping, picnic, and overlook sites. Development is needed by 1980.



MAP 15. POTENTIAL SCENIC HIGHWAYS AND NATURAL RECREATION ATTRACTIONS

See following pages for greater detail.

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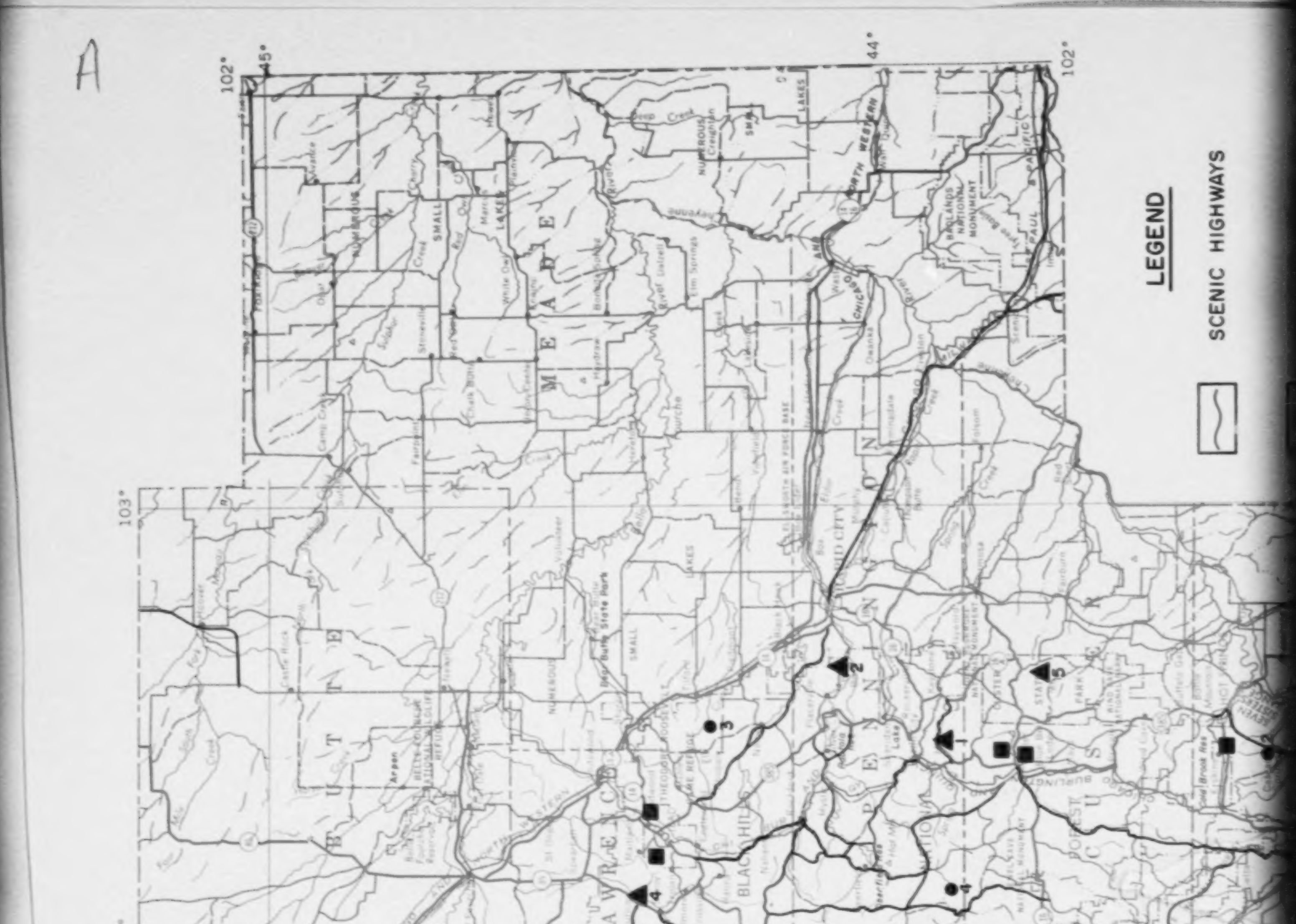
A


LEGEND
SCENIC HIGHWAYS
MEADE
LAWRENCE
BUTTE
PENNINGTON
CUSTER
CROOK
WESTON
SOUTH DAKOTA
WYOMING
BLACK HILLS
RAPID CITY
BADLANDS NATIONAL MONUMENT
Devils Tower National Monument
ELLSWORTH AIR FORCE BASE
102°
103°
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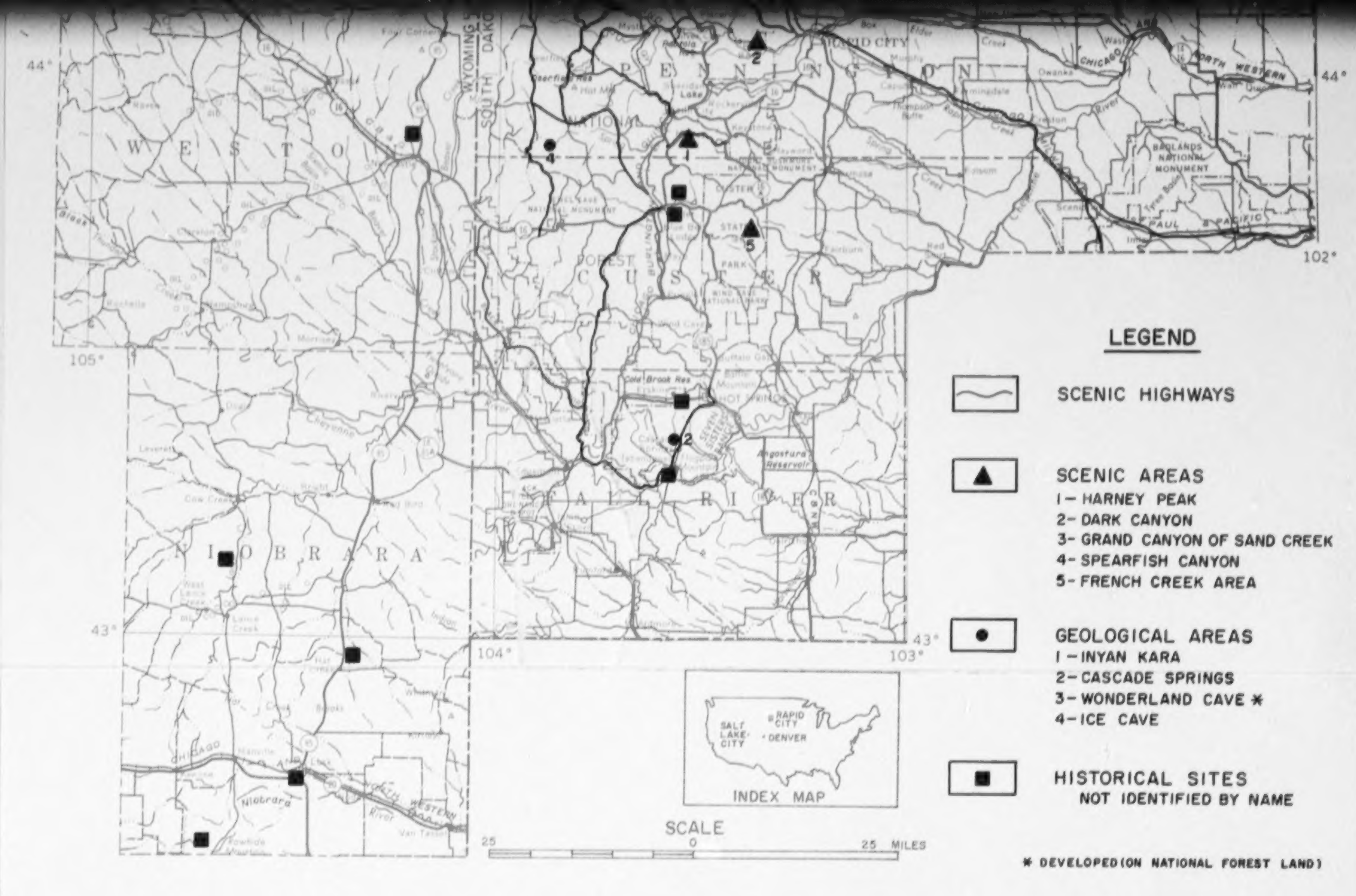


MAP 15. POTENTIAL SCENIC HIGHWAYS AND NATURAL RECREATION ATTRACTIONS

B

Caves.--Numerous caves can be developed by providing access trails, signing and viewing facilities, and in some cases camp or picnic units. The Ice Cave-Bear Cave area is an example.

Others.--Other known significant natural attractions include the Grand Canyon of Sand Creek, Spearfish Canyon, several lesser canyons, Inyan Kara Mountain, Cascade Springs, Stratosphere Bowl, and a number of existing and potential historic attractions, including sites of several old mining towns. In addition, several primitive-type areas should be retained for back-country activities. Management policies should insure protection of all high quality potential recreation attractions.

Opportunities exist for providing additional "sightseeing" use by expanding developments at the five National Park Service areas and at Custer and Bear Butte State Parks. Notable are the possibilities of opening additional caverns at Jewel and Wind Caves and of adding portions of the scenic Air Force Gunnery Range to Badlands National Monument. All of the above-named areas are judged to have the potential to handle visitor needs through the year 2000.

In improving the winding and often narrow highways in the mountainous areas, the use of bypasses, vista point parking areas, rest stops, more turnouts, and perhaps some one-way sections, are recommended. Highways in the Hills, and in particular in the central Hills, offer a good potential for such improvements. The tunnels, pigtail turns, bridges, and "split" sections as found on U. S. Highway 16A should be retained. New, low-speed, high-standard, paved scenic roads should be constructed. At present, 13 have been identified, and they are shown on map 15. Addition of these to the present scenic highway system will help the area support considerably more sightseeing use.

The potential for developing visitor centers and providing exhibits, evening programs, or other interpretive devices is significant. The greatest opportunities for such developments are found on the lands administered by the National Park Service, Forest Service, the two States, and larger communities.

There is an especially important opportunity to provide more signing and interpretation of historic points, unusual rock formations, canyons and at view points, and to present a visual story of the area's geologic history and wildlife.

In identifying, protecting, and developing important historic sites, stronger and better funded State-directed programs are needed. Federal and local agency and landowner assistance will be required, especially in providing protection to and information on potential sites.

Although the development of camping and picnicking sites has kept close to the increase in demand, a greater variety of areas is needed.

These might include wilderness-type sites, deluxe camps, trailhead campgrounds, high quality roadside picnic sites and group areas. Group picnic sites will be popular near urban areas, while group campgrounds will become increasingly useful for handling trailer caravans, youth groups, and other organized travelers.

Photo 33. Many new vista point parking areas and several new visitor centers will be required. Here at Pactola Reservoir, the Forest Service combines both at one site.

One of the greatest yet least developed land-based recreation potentials is for hiking, riding, and nature trails. The most intriguing potential is the so-called "Black Hills Trail." This scenic trail could extend from Wind Cave National Park to Devils Tower National Monument, connecting Custer State Park, Jewell Cave, Mount Rushmore, Sheridan and Pactola Lakes, and the Bear Lodge Mountains. Associated developments would include campgrounds, trail shelters, overlooks, horse rental concessions, and informational signing.

Public recreation agencies should encourage more spring and fall recreation use. Included would be more intensive management of game animals and relaxed restrictions on nonresident hunting; construction of more limited-facility hunter camps; improvement of the area's cold-water fisheries and encouragement of greater use of warm-water fisheries; and promotion of gemstone collecting opportunities.

The potential for additional hunting, as described under "Fish and Wildlife," carries several future limitations. By 1990, big game and certain other hunting likely will be increased at the expense of hunter success.

Communities and public agencies can and should provide more sites for the winter sports of skating and sledding. All potential sites for skiing and other winter sports should be investigated to identify those with the greatest possibilities. Skier demand soon may warrant an additional ski area with provisions for artificial snow. Certainly a new area will be warranted by the year 1980. By the year 2000, a major expansion or yet another area should be economically feasible. Limitations imposed by snow depth, temperature, and length of runs, however, point out that emphasis will need to be placed primarily on attracting local residents.

Water-based recreation.--The overall water-based potential is somewhat limited. The area has the potential in water-based recreation resources to meet the needs for swimming until the year 2020 and probably beyond. Through full utilization of existing and potential reservoirs, including all warm-water fisheries, demands for fishing probably can be met until 2020. The demand for quality trout fishing, however, cannot be met, as the present supply and future supply are limited. The potential to satisfy all demands for boating and water skiing will be present only until about 1985 or 1990. Beyond this time, speed boating and water skiing opportunities will be very limited. Most low-speed boating can be accommodated until 2010 or 2020 if potential reservoirs are fully developed and fast boating and water skiing are restricted. Water-based recreation potentials involve "existing reservoirs," "potential reservoirs," and "streams."

Significant increases in facilities can be made at the six major existing reservoirs. Sheridan Lake, Pactola and Deerfield Reservoirs are cold-water lakes in the central Hills. They are more in demand and more intensively developed than Angostura, Belle Fourche, and Keyhole, which are outlying, warm-water reservoirs. Full development of the lakes in the central Hills can be realized within 10 years, while complete development of the others will involve extensive construction and take longer. Belle Fourche Reservoir should be provided with an initial recreation area as soon as possible.

Potential at the above reservoirs includes improvement of existing facilities, a large increase in the number of camp and picnic units, expansion of existing and development of a number of new boat launching sites and swimming beaches, and addition of several lodges and marinas to be built with private capital. There will be other opportunities for playgrounds, amphitheaters, trails, overlooks, and concession developments. Provisions for improved access, signing and shade are especially important at Angostura, Belle Fourche, and Keyhole Reservoirs.

Some of the smaller lakes, particularly in the central and southern Hills, could handle increased visitor loads through expansion and major upgrading of existing facilities. Improved watershed management and, in some cases, deepening and silt removal would help.

The limited supply of water in the area indicates that all feasible potential reservoirs should be developed by the year 2000 (map 11). Reservoirs that offer cold-water fishing and scenic surroundings will be most popular. Those that are built will be fully utilized well before 2000.

Reservoir sites in the Hills area.--Most of the 28 potential reservoirs in this area have been identified by the Forest Service or the South Dakota Department of Game, Fish and Parks. Sites range in size from 5 to 140 surface acres. The aggregate total would be approximately 1,100 surface acres of water. Most or all of these sites should be developed primarily for recreation and streamflow improvement. Generally, sufficient adjacent land for recreation development is available.

Reservoir sites on the edge of the Hills.--The larger of the 12 potential sites on the edge of the Hills have been identified by the Corps of Engineers. The sites range in size from 60 surface acres to 7,000, and total surface acreage is approximately 9,000. These reservoirs would be multipurpose, with most serving a primary function of flood control. Tentatively, all appear to have recreation potential, although water levels could vary considerably. It is important that all sites with recreation potential be constructed and regulated so as to provide for a conservation pool and the maximum water level possible during the recreation season. Most of these sites have a reasonable amount of developable recreation land nearby, and facilities could be constructed for several activities.

Reservoir sites in the Plains area.--Approximately 40 locations, ranging in size from 2 surface acres to 19,000 have been identified in the Plains by several agencies. Most of the sites are small to medium in size, but four exceed 2,000 surface acres. Most or all would be multipurpose reservoirs, and all could be subject to a considerable fluctuation in water level. Most of the larger sites appear to have a fairly substantial recreation potential, and generally, developable recreation land is available.

Although the maximum potential water surface area for recreation use is an estimated 54,000 acres, considerably less might be available because of competing demands, unattractive locations, and reservoir sites that prove infeasible.

On the national forest, streams offer significant potential for development, while lesser opportunities exist in Custer State Park and on other lands. Good access, parking, camp and picnic sites, and trails should be provided. Many of the streams are small, but quality can be improved by controlling pollution and siltation and maintaining streamflows. However, maintenance of streamflows and water levels in upstream recreation reservoirs may at times conflict. There is estimated to be enough stream area potential to provide for recreation development continuing through the year 1985.

Most cities and larger towns in the area have an opportunity to develop additional water-oriented parks, small recreation lakes and other open areas. Park development is especially desirable along streams in heavily built-up areas, which often become focal points for trash piles, shabby developments, and even small slum areas. Through land acquisition, planning, cleanup, landscaping, and the addition of walks, steps, footbridges, small rock dams and other improvements, problem areas can be converted into refreshing coves of beauty and tranquillity. The most notable potential for streamway development is on Rapid Creek at Rapid City. Consideration should be given to zoning such low-lying, flood susceptible areas for parks.

The Private Sector

The future of the private recreation industry in the Black Hills area is interrelated with and partially dependent on the public sector. The public sector provides the bulk of the basic recreation resource. But the private sector provides the majority of the facilities that enable visitors to eat, sleep, and play in the area. The potential for private development is very promising. Other than for a limited number of water-based developments, no severe shortages are foreseen through 2020.

Private development categories.--The supply of motels, hotels and lodges is expected to stay in balance with mounting demand. There is, however, an important potential for more deluxe motels and first-class lodges and resorts that offer touring services, swimming, fishing, golfing, hiking, evening programs, and relaxation in scenic settings. Dude ranches offering a full range of western experiences will provide a further though limited opportunity. These represent one of the most important untapped potentials of the area. To be successful, however, a regional reputation must be established for truly relaxing vacations.

Deluxe resorts will require large investments. Special tax incentives, liberalized financing, and contributions of land purchased for private investors by local government, would stimulate such investments. Another help would be a business advisory group to supply assistance and information to any potential developer.

The potential for future development of private campgrounds and trailer parks, as indicated in the recent rapid growth of this industry, is great. Success will be greatest with operations that emphasize luxury, variety, and convenience in the facilities and services offered. There is considerable opportunity for developing landscaped ponds, lakes, and small streams in private campground areas.

Photo 34. The Black Hills area will need more scenically located first-class lodges and resorts, similar to this development.

Photo 35. Small streams, lakes and ponds can add a new dimension to camping in privately operated campgrounds and trailer parks.

Low-quality campgrounds adversely affect an area's overall reputation and can reduce business at other better sites. The most successful means of improving less desirable developments will result from tourist preference and a strengthening of the local campground owners' association.

Much of what was said about private campgrounds also applies to private attractions. In general, the higher quality and more attractive developments receive more patronage.

Attractions that put emphasis on things of interest to the entire family, on self-participation, and on the Western flavor, natural resources and unique local features should, generally, remain popular. Reconstruction of historic places and dramatic re-creation of historic events have proved popular and can be further developed, if tastefully and impressively done. Indian history is an interesting asset of the area. Consideration should be given also to the development of farm ponds, seminatural fee fishing sites, exhibits and additional natural attractions.

Rides and tours are expected to increase gradually until stimulated by completion of the net of high standard scenic roads described earlier. Future consideration should be given to establishment of a deluxe touring service that would offer two and three day trips with above average lodging and meals and frequent stops for special entertainment, sports participation, sightseeing, and general relaxation.

Whenever possible, new chairlifts should be combined with winter sports operations. Horseback riding should receive a boost from new trails constructed on public lands. The potential for developing additional old authentic train ride trackage and equipment appears promising but might be economically more sound if restricted to interconnected systems or, at most, two reasonably long narrow-gage lines.

The future of additional game and sports developments appears promising, especially for golf courses and swimming pools. Golf opportunities include development of small "par 3" courses that will be especially adaptable to resort operations. The potential for swimming includes development of many smaller pools, a limited number of small beaches, and even winter-summer pools with movable overhead buildings. The potential exists for development near Rapid City of a commercial winter play area, offering a full range of snow and ice activities.

Opportunities that could affect the tourism industry generally.--An obvious key to attracting more people to the area is effective national advertising. In particular, there is an opportunity to put more stress on bringing visitors to the area in spring and fall by emphasizing the mild weather, lower rates, uncrowded highways, and hunting opportunities. An annual Black Hills Festival, preferably in the fall, featuring outdoor drama, a major rodeo, or other sports contest or even a Monte Carlo type road race, might be helpful.

The Black Hills is peculiarly subject to heavy visitation on certain days of the week and from mid-June through late August. To encourage more uniform summer use, areawide low rates and special entertainment or other slack period inducements should be tried. Since most people plan their vacations well in advance, there is an opportunity to send those who write for information suggested itineraries that would promote extended tours. One and two day trips are now more common. The "Linger Longer" promotional campaign, emphasizing lesser known Hills' attractions and other activities such as farm auctions and back-road touring, is certainly a step in the right direction and worth a fair trial.

Finally, it would be desirable to encourage more unified action and advertising by recreation industry owners by expanding one or more owner or promotional organizations to include the Wyoming portion of the area.

Conclusions

Development of the recreation resource will be greater and more efficient if it is planned and centered on the needs of people and the greatest potentials of the area. Based on this objective, the following conclusions can be made:

1. Recreation management should be improved through (a) better public-private coordination, (b) more emphasis on improvement of existing sites, advance planning, and good design, (c) better and more comprehensive financing of and participation in State, county, and community recreation programs, and (d) more intensive study of visitor use, preferences, and needs.

2. Primary promotional emphasis should be placed on the area's land-based recreation assets. Public facilities for camping, picnicking, and sightseeing should be expanded according to future demand. Related goals should include (a) dispersement of use through construction in lightly developed areas, especially the western Hills, (b) a gradual development of all outstanding potential natural attractions by the year 2000, with complete development of the Harney Peak, Dark Canyon, and French Creek areas by 1980, and (c) increased efforts in visitor information-interpretive activities by all recreation agencies and the private sector, with greater emphasis on the history, geology, and wildlife of the area. Several areas in semiwild condition, both in and outside of the Hills, should be retained.

3. Existing scenic highways should be retained with their present unique characteristics. An additional network of low-speed, high-standard scenic roads should be built within the next 20 years. Many turnouts and vista point parking areas should be added to existing highways and included in the design of new highways. An extensive system of hiking, riding, and nature trails should be developed.

4. Greater off-season and slack period recreation use and longer visits should be encouraged. Additional study should be made of potential ski areas, a major fall festival or other event, and other special incentives.

5. The recreation potential of all existing bodies of water in the area should be fully developed within the next 20 years. Intensive development of all waters in the Hills area should be accomplished within 10 years. All potential reservoirs with good recreation opportunities will be needed by 2000. Communities should place more emphasis on the development of water-oriented parks and streamways.

6. "Complete vacation package" lodges, resorts, and dude ranches should be developed. More emphasis should be placed on quality attractions. Development of additional natural-appearing water areas, swimming facilities, golf courses, and other sports facilities is needed.

FISH AND WILDLIFE

Fish Habitat (cold and warm water)

Present fishing capacity could be increased to a maximum of about 980,000 fisherman-days through stream renovation and intensification of put-and-take stocking of legal-size trout. Since put-and-take management is subject to progressively higher costs and diminishing satisfaction, it would be better to increase the base capacity of waters to support wild fish and sustain them by intensive planting of fingerlings. Capacity increases would then be closely tied to the availability of usable water and developments for other recreation purposes.

Reservoir Construction (multiple and single purpose)

The greatest opportunity to provide more cold-water fishing for wild trout in the Black Hills area is through construction of additional impoundments. Impoundment sites (table 45) have been evaluated for their potential to help fulfill the accelerating future demand for fishing. Storage sites on Sand Creek and Cold Spring Creek in Wyoming have not yet been identified but would have high value if used to augment streamflows. However, reservoirs should not be built or operated primarily for fishing value if such use is detrimental to downstream fishing. The most promising reservoir sites for sustaining trout

Table 45.—Estimated fisherman-days for potential reservoirs (map 11) 1/

	Surface	Fisherman-days		Downstream benefits	
Reservoir sites	acres	1980	2000	miles	fisherman-days
Cold-water lakes					
U.S. Forest Service (Sites 1-18)	719	177,250	No change	63	1,765
South Dakota Dept. of Game, Fish & Parks (Sites 19-27)	371	89,680	No change	26	145
Bureau of Reclamation (Site 28)	390	9,750	No change	3	15
Corps of Engineers (Sites 30, 31, 33, 34, 37-40)	5,267	856,600	No change	73	5,840
Soil Conservation Service (Sites 42-52, 54-59, 61, 63, 66-70)	1,827	403,900	No change	45	240
Total	8,574	1,537,180	No change	210	8,005
Warm-water lakes					
Bureau of Reclamation (Site 29)	830	4,150	No change	40	200
Corps of Engineers (Sites 32,35, 36, 41)	44,450	115,250	No change	105	525
Soil Conservation Service (Sites 53, 60, 62, 64, 65, 71-81)	200	1,000	No change	15	15
Total	45,480	120,400	No change	160	740
Grand Total	54,054	1,657,580		370	8,745

1/ For a complete list of potential reservoir sites, see table 49.

fishing through intensive planting of fingerlings are near the limestone plateau on reaches above bog iron, mine, and domestic pollution.

While there is significant variability in anticipated fishery value from one site to another, construction of about 5 percent of the potential reservoir acreage suitable for trout could satisfy the current annual 73,000 fisherman-days of unfulfilled demand for trout fishing. An additional 15 percent of the reservoir acreage would be needed to satisfy the anticipated, greatly increased future demand for trout fishing in 1980. Thus, to keep up with the increasing demand for trout fishing, about one-fifth of the 60 cold-water reservoirs now identified could be used by the year 1980.

Future development of only five potential warm-water reservoir sites with about 45,000 surface acres could be expected to provide about 121,000 fisherman-days in addition to substantial amounts of commercial fish.

Numerous water improvements are planned by the Bureau of Land Management in the next five years, and the fish potential of each must be explored as part of overall planning. The larger water retention structures will incorporate warm-water fishing as one of the water uses, and although the demand is not as great as for cold-water fishing, these facilities can supply considerable high-quality fishing in the future. These impoundments can be expected to provide about 75 fisherman-days per acre annually.

Coupled with the opportunities for fisheries development in both existing and future reservoirs is the opportunity for identification of, and access to, streams suitable for fishing. Fishing on warm-water reservoirs could be substantially increased with more boat-launching and other fishermen facilities along shore lines (photo 36). All significant public lands and waters should be identified on maps and on the ground.

Retention and Improvement of Quality Streams

The best way to retain quality fishing streams in the area lies in prevention and abatement of pollution through the adoption of adequate water quality standards equal or exceeding those listed in table 46. Standards and criteria should be in accord with the Federal Water Pollution Control Act, Public Law 84-660, as amended. Water quality standards suitable for fish life are normally higher than those required by agriculture, industry, or municipalities. More than 200 miles of the most seriously polluted streams are shown on map 11 and evaluated with pollution abated in table 47.

Poor road location, construction and maintenance probably have been the most serious degrading factors for trout streams in the Hills (photo 37). There are opportunities to save and even improve many miles of trout stream by the type of legislation recently enacted in

Photo 36. Boat-launching facilities tend to attract fishermen and help to insure full utilization of the fishery.

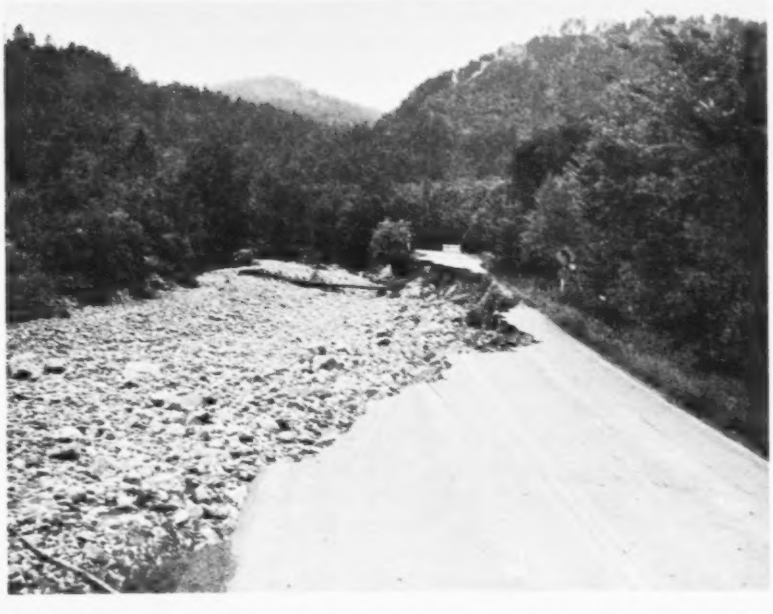


Photo 37. Flood-damaged section of the Spearfish Canyon road (U.S. 14A), located in the stream bottom.

Table 46.—Quality objectives for waters for fish and wildlife

Item	Acceptable criteria
Floating and settleable solids	None
Total dissolved solids	Not greater than 1000 mg/l
Suspended solids	Not over 10 percent more than the value found in the immediate upper reach of the stream
pH	6.7 - 8.6
Dissolved oxygen (daily average)	5-10 mg/l
Heavy metals, toxic substances	None in toxic concentrations
Oil, sulfides or phenolic compounds	None
Temperature	
Cold-water fish	52-70°F
Warm-water fish	65-80°F

Montana setting forth minimum construction standards, or acceptance of effective guidelines by construction agencies. Such guidelines would include specific criteria for pool, riffle, depth, and width ratios; control of siltation; and preservation of streambank vegetation and aesthetic values. Pollution by fuel and road oil would be prevented. In general, all roads should be located as far as practicable from streams, rechanneling and stream straightening kept to a minimum, scarifying streamside areas avoided, and stream gradient changes minimized.

Future iron mining may pose a threat to the fishing resource in the Hills area. Various iron ore deposits are present in at least eight Black Hills drainages. Development of these deposits might require large volumes of water and create problems in water quality management.

Stream fishing opportunities would be greatly enhanced if minimum flows could be maintained during periods important to fish and critical for reproduction and growth of fish. At such times, 10 percent of the mean annual flow for warm-water streams and 66 percent of the mean annual flow for cold-water streams are required. These minimum requirements might safely be reduced by as much as 50 percent during other periods of the year. Construction of additional reservoirs should afford many opportunities to provide these base flows for fish and fishing in the future.

Table 47.—Estimated fisherman-days resulting from stream improvement measures

Name of stream	Improvement measure	Miles affected	Fisherman-days 1980 1/	2000
Rapid Cr.	Pollution abatement	40	8,000	No change
Whitewood Cr.	Pollution abatement	21	4,200	No change
Hop Cr.	Pollution abatement	2	200	No change
French Cr.	Pollution abatement	2.5	500	No change
Castle Cr.	Pollution abatement	13.0	2,470	No change
N. Fk. Castle Cr.	Pollution abatement	4.5	900	No change
Battle Cr.	Pollution abatement	6	704	No change
Belle Fourche R.	Pollution abatement	116	580	1,160
Cheyenne R.	Pollution abatement	20	100	200
False Bottom Cr.	Sealing sinkholes	36	4,500	No change
Elk Cr.	Sealing sinkholes	20	3,750	No change
Little Elk Cr.	Sealing sinkholes	24	2,280	No change
Boxelder Cr.	Sealing sinkholes	20	2,220	No change
Spring Cr.	Sealing sinkholes	18	2,250	No change
Battle Cr.	Sealing sinkholes	24	1,800	No change
Grace Coolidge Cr.	Sealing sinkholes	36	4,500	No change
French Cr.	Sealing sinkholes	30	3,750	No change
Spearfish Cr.	Mitigate diversions	36	10,368	No change
Subtotal		469	53,072	53,752
All streams	Access provided	-	40,000	
All streams	Watershed managed for yield	-	20,000	
All streams	Water quality standards adopted	-	20,000	
Total			133,072	133,752

1/ Completion accomplished on or before 1980.

Additional fishing opportunities can be provided through utilization of new fish rehabilitation projects. As an example, eradication of the native fish and introduction of smallmouth bass into lower reaches of the Redwater River and Elk, Boxelder, Spring, and Battle Creeks may greatly increase available high quality fishing.

The development of a commercial fishery may offer an opportunity to improve the quality of several streams and reservoirs in the area for game fish, and at the same time provide additional employment and add measurably to the protein food supply. About 425 miles of the Cheyenne, Belle Fourche, and Little Missouri Rivers and 17,000 acres of Angostura, Belle Fourche, and Keyhole Reservoirs could safely support an annual commercial food fish harvest of more than 150 tons.

Current studies indicate that utilization of fish for industrial purposes in the inland lakes and reservoirs may be feasible in the near future. Such utilization could support commercial production considerably in excess of the 150 tons estimated for food fish only.

Restoration of Streams

Improved watershed management and pollution abatement hold the greatest promise for stream restoration. Timber thinning and judicious grazing management, ecologists believe, might be used to increase streamflows significantly. If improved management increased watershed yield in surface runoff by as much as 30 percent, it would provide an estimated 20,000 additional fisherman-days annually, and together with pollution abatement restore much of the past loss of trout streams.

Approximately 25,000 additional man-days of trout fishing might be provided by sealing or bypassing sinkholes (map 11 and table 47). Possible side-effects of sealing channels against loss, however, should be studied on an individual location basis and a determination should be made prior to any construction so that intolerable conflicts with other uses will not develop. Additional quality trout fishing could be restored by eliminating total stream diversions such as now occur on Spearfish Creek.

Wildlife Habitat

Forest management.--The overall management plan of each landowner or public agency should consider production of a variety of vegetative types. Most forest-dwelling wildlife thrive in habitats that contain a mixture of conifers, hardwoods, shrubs, forbs, and grass. In general, birds and mammals tend to prefer areas where two or more vegetation types meet, and avoid large areas of monotypic vegetation such as a pure ponderosa pine stand.

Improvement cutting and thinning of forest stands of conifers, based upon direct benefits from pulp or other wood utilization, has several beneficial secondary effects. They should result in a large increase in browse production and create "edge" in the resultant openings in heavy timber. These operations also reduce the amount of precipitation intercepted by tree crowns. Thinning can be expected to be most productive in deer winter range areas, especially on south and southwest slopes (photo 38).

Potential development and improved management of forested lands include many opportunities for increasing wildlife production. Appropriate measures include (1) browse plantings on old burns or areas of low site quality, (2) creation of temporary openings in heavy timber stands by harvest cuts, (3) construction of water facilities where water is limited, (4) planting small grain patches and herbaceous cover in forest openings, and (5) construction of turkey watering facilities (guzzlers).

Photo 38. This thinned timber stand promotes vigorous pine growth, improves streamflows, and provides a valuable understory of big-game browse.

Rangeland management.--As with forest types, management planning should strive for a variety of vegetation. A mixture of grasses, forbs, and native shrubs will provide a more productive habitat than will large areas of monotypic vegetation.

Domestic livestock ranges under proper management help achieve maximum quantity and quality of water yield and maintain sustained production of vegetation of value to wildlife. Wherever high animal concentrations are allowed along stream courses and on bottom lands, extensive erosion and damaged stream fisheries result. Improved fencing and salt and water distribution result in better dispersal of livestock grazing. Fencing practices should promote the welfare of antelope to the greatest extent possible by recognition of the migration habits of the herds.

Potential multipurpose development and improved management of rangelands include many opportunities for improving wildlife production. Specific opportunities include (1) construction of a large number of small ponds for game and livestock water—1,200 are proposed on national grasslands alone, (2) fencing of areas up to 10 acres around each pond to provide cover for upland birds and waterfowl (photo 39), (3) fencing 1- to 2-acre exclosures for sharp-tailed grouse, (4) restoration of overused range by reseeding and resting, (5) improved access to public lands by identifying such lands on the ground to the public, and (6) sagebrush, hardwoods, and other browse plants, important for wildlife

Photo 39. Some fencing is necessary around ponds to promote shoreline vegetation and provide upland game and waterfowl nesting areas.

forage, should be retained in suitable quantity. All of these improvements and practices should be accomplished and operational on forest and rangelands by or before 1980.

Wetland preservation.--Preservation of existing wetlands and creation of new wetlands should be given high priority in wildlife habitat improvement plans. Large reservoirs are not considered as wetlands; however, portions can be managed or improved to create wetlands. Although reservoirs and wetlands can be managed for fish and waterfowl, their edges provide suitable cover for game birds and mammals.

Other measures.--Opportunities for improvement of the wildlife resources in the Hills can be realized from several additional measures which are not related to any specific one of the aforementioned habitat types. These measures include:

1. Continued research into the interrelation of wildlife and their environment. Specific knowledge of populations, movements, and habitat improvements in the area is essential to proper management.

2. Manipulation of deer populations through deer harvest regulations. A continual emphasis on antlerless deer seasons, pre- and post-seasons and special license areas will result in better use of this wildlife resource.

3. Close interstate cooperation and planning to increase efficient use of those segments of the antelope resource that are located adjacent to two or more States.

4. Utilization of the mountain goat resource in the Harney Peak area to provide additional hunting opportunities for a trophy species and benefit the herd.

5. Use of game not now hunted, particularly mourning dove, should be seriously considered.

6. Increased public access to stock ponds and other waterfowl shooting areas on private land, including access for turkey hunting, would permit important increases in hunting opportunities.

7. Revision of restrictions in South Dakota on nonresident hunting of waterfowl would be beneficial. Revision of State laws pertaining to lands in national forest in Wyoming not classified as Wilderness Areas would measurably increase potential opportunities for hunting. Revision of Wyoming's Guide Law would also eliminate some important game management problems that now exist. The present law results in an undesirable concentration of hunters and hunting pressure on private lands.

Table 48 shows measures for significantly increasing hunting opportunities in the Black Hills. If most of these measures are adopted, and as demand begins to press hard on supply in future years, the total increase of 31,600 hunter days could double and an acceptable degree of hunting quality could be maintained.

Conclusions

If the present status of fish and wildlife resources is to be maintained and improved as an important aspect of outdoor recreation in the Black Hills, the following conclusions should serve as guidelines for future development and management:

1. Approximately 2,000 surface acres in no less than 5 sites of the potential reservoirs suitable for cold-water fishing will be needed by 1980.

2. Water quality standards should be adopted conforming to the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.), to restore and retain high quality fishing waters throughout the study area.

3. Stream preservation laws should be enacted by South Dakota and Wyoming that include specific guidelines to road construction agencies for preventing or mitigating damage to natural streams in connection with work on all roads and highways.

Table 48.—Estimated benefits of principal improvement measures for wildlife

Item	Improvement measures	Estimated annual increase hunter-days	Species benefited
1	Thining of 400,000 acres and improvement cutting of forestlands	12,500	Deer & elk
		2,000	Turkey
2	Other forest improvements (browse planting, harvest cuts and herbaceous plantings)	5,000	Deer & elk
		3,000	Turkey
3	Intensive management of rangelands (water development, fenced enclosures, range restoration, maintaining adequate browse plants, access improvement)	2,100	Antelope
		6,400	Deer
		*	Waterfowl
		650	Grouse
4	Improvement of harvest regulations and enabling and corrective State legislation; increased research	*	Most species
Implementation of the above measures		(23,900	Deer & elk
		(5,000	Turkey
		(2,100	Antelope
		(650	Upland birds
		(*	Other species
Total		31,650+	

* These measures will result in substantial hunter-day increases, but estimates are extremely variable and depend upon analysis of individual cases. For example, development of 600 fenced stock ponds could provide 1,200 waterfowl broods annually, but this cannot be converted into Black Hills' hunting.

4. Access for fishermen should be provided along privately owned reaches of streams, either by easements or fee purchases.

5. Allocation of water for fish and wildlife use should be established in law.

6. Development of commercial fishing, using excess and unutilized fish populations, should be encouraged.

7. The fish and wildlife development and management program should be expanded and accelerated on rangelands.

8. A greatly expanded applied research program should be implemented on the interrelationship of fish and wildlife resources with their environment, with continuing emphasis on benefits of multiple-purpose planning.

In addition to the above primary conclusions, the full development of fish and wildlife resources will depend heavily upon action programs of other functions. Specifically these include (1) investigation and construction of potential reservoirs where feasible, (2) development and implementation of a comprehensive program of water pollution control, (3) accelerated precommercial thinning of forest stands to meet multiple-purpose needs, (4) improved mining techniques with subsequent water treatment to maintain or improve the quality of stream environment, (5) full development of the recreation potential of all existing bodies of water, and (6) identification on the ground of all public lands and water areas and the provision of public access.

MANAGEMENT AIDS

Management aids include many of the resource management practices that are performed to some degree by all public resources management agencies and by most private landowners as well.

In almost every instance, such work is performed by each agency to the degree that is judged necessary considering agency responsibility and resource value. For the most part, the problems that occur between individuals, organizations, and public agencies are due to poor communications or a lack of information, or involve duplication or a wide variety of quality standards. All of these problems could be alleviated by an effective coordinating group with areawide interests and responsibilities. Such an organization could be invaluable in fire planning, in recreation, and in zoning and nuisance abatement. It is suggested that one broadly based coordinating group could work effectively in all these fields.

Fire Protection

The protection of our natural resources from wildfire can be increased substantially. Public awareness of the need for fire prevention can be sustained through using new signing and poster techniques, by continually emphasizing public education and through enactment of stronger fire laws. Fire protection should be adjusted in proportion to the fire occurence rate, and the values to be protected.

The need for a more centrally located aerial tanker base should be met by establishing such a facility near Custer, South Dakota. This would place air facilities in a central location for the Black Hills National Forest, the National Grasslands, and other lands needing protection. A suitable site has been selected and preliminary plans drawn. The aerial tanker base at Spearfish would be retained as a secondary unit to be activated when fire conditions warranted.

Weather modification might reduce lightning-caused fires. Research should be expanded in the field of lightning dispersion. Research also is needed to provide more effective fire prevention methods.

Future fire control efforts depend on continued improvement, expansion of facilities, and more effective coordination between fire control agencies. Most existing fire weather stations should be relocated. To meet long-range needs, remote controlled weather stations should be installed to obtain representative fire danger data for the entire Black Hills area.

There are opportunities for closer agency coordination, which should be implemented through an assignment of zones of responsibility to all participants. Where a scattered landownership pattern exists, fire assignments should be zoned, using cooperative agreements. For example, the Forest Service might assume major fire responsibility in the central forested area of the Black Hills. In exchange for the private lands thus protected, the State of South Dakota might assume major protection responsibility for lands in the southern Hills area. Any such division of activity would have to be on an equitable basis and consider the total fire problem. These fire prevention and control activities should be coordinated through an all-agency fire planning board.

Those lands not now adequately protected should be covered. Where it is not feasible for a landowner, whether private or public, to assume or provide full fire protection, the land could receive protection under written agreement, for a stipulated fee. The Exemption Area in the northern Black Hills now receives such protection.

Reduction of the threat of fire in snags, in logging slash, and in other fuels of high hazard can be accomplished through interspersing fire trails in continuous fuels.

Wyoming's fire protection problems can be lessened by initiating a burning permit law for the timbered areas and, equally important, by developing a complete fire radio network system for use by the counties.

Access

Adequate access for the expanding tourist travel, for resident use, and for resource development should be given top priority. With proper planning and adequate funds, the need can be met. Provision should be made for augmented financing and construction of fire access roads in certain areas of Wyoming.

Access roads should be of a quality that will permit public use under most weather conditions. Land exchanges, withdrawals, and sales should be conducted with full consideration for enhancement of public access to, and use of, the public lands for multiple purposes.

Because the area's trout streams are nonnavigable, fishermen access would have to be either a fee-purchase strip along at least one side of the stream, or in the form of an easement. The problem of access could be alleviated in part by purchasing and developing select fishermen access areas of about five acres each along streams. On the Belle Fourche and Cheyenne Rivers, such access sites should be obtained immediately below Angostura and Keyhole Reservoirs and at about five-mile intervals downstream.

To make public lands more easily identifiable, signs, special types of posts, bright markers, or perhaps even a characteristic fence, could be used.

Construction of several new highways and improvement of existing roads are needed to meet present and projected transportation demands. Interstate Highway 90, when completed, will provide a high-speed bypass around the Hills area. Specific conclusions regarding road and highway construction are as follows:

1. An all-weather highway should be constructed in a north-south direction through the Limestone Plateau area from U. S. 16 to U. S. 85 in the general vicinity of Hell Canyon, Ditch Creek, Deerfield Lake, Flag Mountain, and the upper South Rapid Creek drainage area.

2. A modern east-west route should be provided from the Badlands, through the southern part of Custer State Park to Custer, South Dakota, and Moorcroft, Wyoming.

3. East-west access through the northern Hills should be improved by relocation and improvement of the Sturgis-Deadwood and Deadwood-Southwest Forest Highways routes 14A and 85.

4. A modern highway should be constructed from Spearfish Canyon in the vicinity of Cheyenne Crossing or Savoy northwesterly to a junction with U. S. 14 east of Sundance, Wyoming.

5. An all-weather modern highway should be constructed in a north-south direction for scenic access over the top of Bear Lodge Mountains.

6. All-weather roads should be constructed from Clareton southwest to Bill, and from Clareton westward to Reno Junction, in Wyoming.

7. An increased program of all-weather surfacing of secondary access roads throughout the entire area should be started.

Landownership Adjustments

A more contiguous landownership pattern can facilitate efficient resource management programs. To attain this, every attempt should be made to organize both public and private lands into workable management units. In most cases, isolated tracts that cannot be efficiently managed should be disposed of through sale, transfer, or exchange. Individuals and public agencies should pursue an active land adjustment program.

Zoning, Planning, and Other Control

The potential for preserving and enhancing the beauty of the Black Hills is almost unlimited. Realization of specific objectives rests largely with residents and the effort they devote to making the area more inviting.

The need for zoning in the Hills is great. States should provide more direction and enact more comprehensive and clear-cut legislation. Well-framed laws would permit and encourage private citizens, counties, and groups of counties to develop and initiate good zoning and land use practices. Land use plans are a prerequisite to effective zoning.

Coordinated, strengthened, and complete zoning is needed in all nine counties as well as a regional planning board in each State. There is also a potential for planning and zoning commissions for incorporated towns. County authority should prevail beyond corporate limits where problem developments, such as dumps, junkyards, and other eyesores, are likely to be placed. Both technical guidance and financial aid for planning are available under several Federal programs.

A coordinating group, composed of local, State and Federal agencies and private groups, could develop and encourage the use of minimum standards and guidelines for recreation facilities and zoning for billboards, junkyards, utility lines, and other roadside problems. There is a considerable potential for the use of underground utilities. Such use could add significantly to the attractiveness of the communities and scenic portions of the region. Specific conclusions relating to zoning, planning, and other control are as follows:

1. Zoning boards should be established and activities coordinated between South Dakota and Wyoming.

2. Public land administrators should coordinate zoning controls on public lands.

3. Local groups should be formed to stimulate interest in roadside beautification.

4. Stricter enforcement of regulations covering littering, vandalism, junkyards, dumps, and signs is needed.

Scenic easements should be purchased, insuring the preservation of outstanding roadside beauty.

More attention should be devoted to the design and construction of roads and highways that not only move traffic safely and efficiently but retain aesthetic, scenic, and fish and wildlife values. The following are construction practices to be avoided: Deep cuts and high fills that will remain treeless for years; long, uninteresting stretches of road; stream channel encroachment; canyon-bottom locations; and missed opportunities for views or vista points.

To help eliminate littering and vandalism, State and Federal officers should receive complete cooperation in punishing violators.

LAND

The present pattern of land use will change little in the future; however, multiple use of the land resource must be expanded.

Requirements

Maximum development in the next half century may change present land use on less than one percent of the total area. Urban expansion, new reservoirs, new roads, and intensively developed recreation areas will account for most of the lands diverted from other uses. Some land surface values may be depleted through mining operations, but much of this land can be used for other activities. Nearly all of the land converted to new uses will come from lands now used primarily for crop, grass, or timber production.

Agricultural and timber industries will not be seriously affected by loss of land to other uses. Advanced technology and improved management should more than compensate for the land losses.

A conflict of interest could develop in some management areas but, generally, good management in one industry will enhance the opportunity for multiple use by another industry. A good example is thinning forest stands. An improved forest not only increases timber production but also provides better wildlife habitat.

The potential for alternative land uses is limited. Generally, economic needs will dictate the ultimate use of the land. Local people can prevent improper use of certain lands through good zoning laws that preclude, for example, new construction on flood plains. An alternative use for city lands susceptible to floods would be for parks. In agricultural areas, frequently flooded cropland could be used as pasture or developed as wildlife areas.

Alternative land uses also should be considered when locating new roads. The best route for a highway may not always be the least expensive. Aesthetic, fish and wildlife, historical, and other values should be given proper consideration when highway routes are selected.

With increased demand on the land resource, including multiple use, it is essential that it be used according to its capability and treated according to its needs. The capabilities of the land will vary because some soils are more susceptible to erosion and damage under different uses than are others. Under these conditions, it becomes necessary to provide conservation treatment measures that will protect against soil loss and erosion damage. Conservation treatment measures applied, as needed, to the cropland, grassland, and timberland usually will provide wildlife cover and habitat. With this also will come recreation use on much of the land. This more intensive use, and/or multiple use, will require an acceleration of local, State, and Federal conservation programs.

WATER

Storage

Considerable water is lost when streams cross the Pahasapa and Minnelusa limestones. Although such losses may be damaging to fish or nearby irrigation, they may be valuable for their ground-water recharge potential. Recharge might be increased by the construction of dams or holding basins where sinks occur. The recharge thus induced could provide additional water supplies for ground-water irrigation.

Conversely, any water saved from sinkholes would enhance the fishery potential and make more irrigation possible. Temporary facilities to pass water over sinkholes have been destroyed in the past when high flows occurred.

A research project on selected Black Hills streams has been started by the South Dakota Water Resources Research Institute. This work will determine stream losses, how much water returns to the surface as resurgent springs, and how much enters the artesian system. At the conclusion of the project, a decision can be made as to the feasibility of preventing or inducing ground-water recharge in the limestone sinkhole areas. Data gathered will help determine the need for additional work of this type on other streams.

In general, reservoir construction for other than flood control or ground-water recharge should be confined to the area of igneous and metamorphic rocks in the central portion of the Black Hills or in the lower foothill region where stream valleys are underlain by relatively impermeable formations. Reservoir sites that include outcrops of limestone and/or sandstone could have large water losses. The areas having a potential for major water losses are shown on map 16.

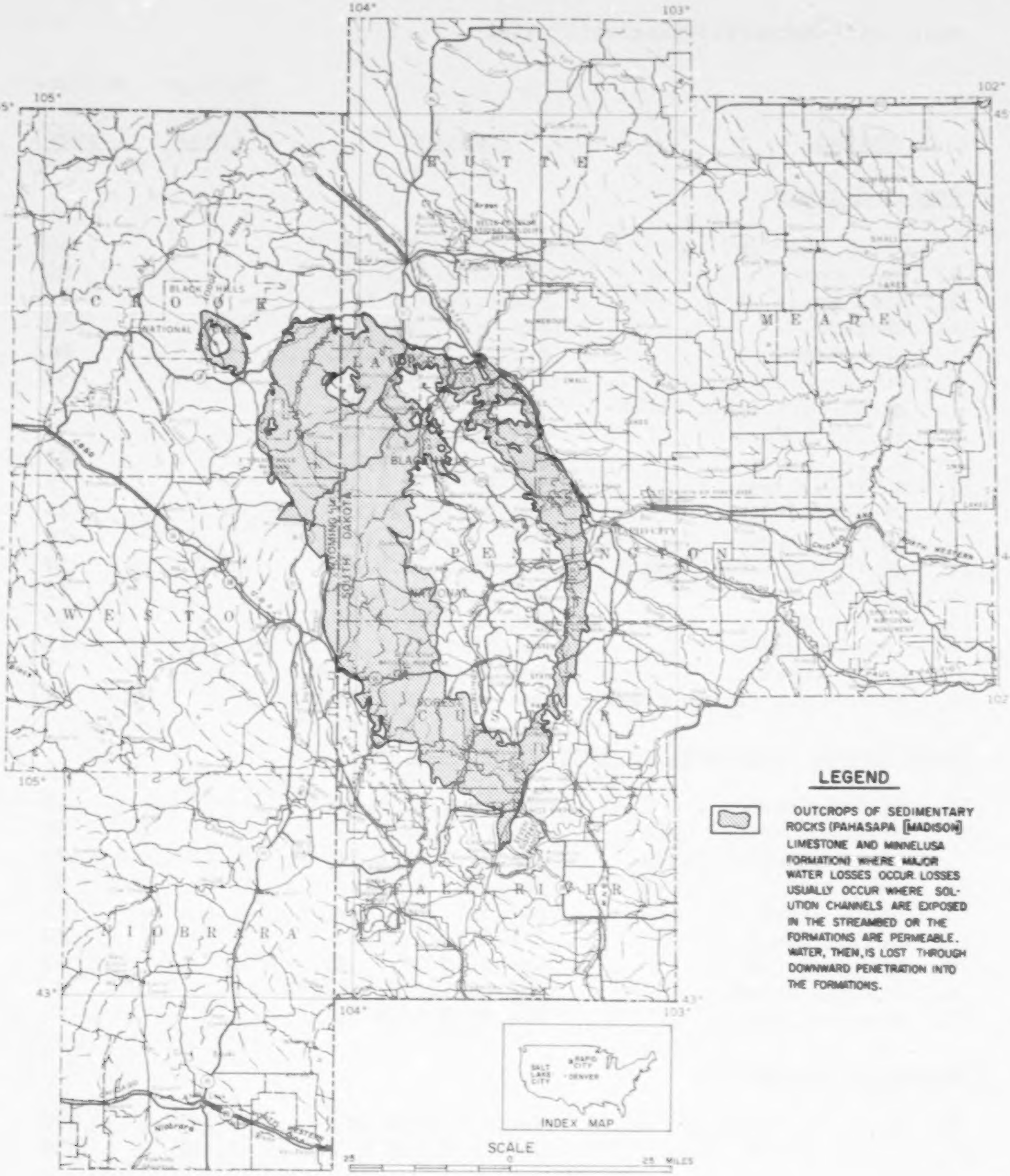
State and Federal agencies have considered a number of possible reservoir sites in the area, most of which are no more than locations chosen without regard to possible conflicts with existing water rights or engineering and economic feasibility. A tabulation of these possible sites is given in table 49 and shown on map 11.

After giving preliminary consideration to some 50 potential sites, the Corps of Engineers is making detailed studies of the reservoir sites numbered 30 through 41 in its current investigation of the Cheyenne River Basin. Also, the Bureau of Reclamation has made reconnaissance investigations of reservoir sites numbered 28 and 29. The Soil Conservation Service has tentatively considered a number of reservoir sites under the Watershed Protection and Flood Prevention Act.

Municipal and industrial water supplies in the area appear to be adequate for the immediate future. All of the major population centers obtain their water supplies from ground-water sources, except Rapid City which utilizes a combination of natural springs and storage in Pactola and Deerfield Reservoirs. It is estimated that these sources will yield a firm municipal supply for Rapid City until about 1975. The other major population centers can, in most cases, develop additional supplies by adding wells.

Additional municipal and industrial water could be developed for Rapid City by (1) purchasing the rights to the water now being utilized for irrigation along Rapid Creek below the city—rights can be purchased as need for water develops; (2) developing multiple-purpose reservoirs on Black Hills streams—other multiple purposes should be those that do not consumptively use water; and (3) pumping water from Oahe Reservoir on the Missouri River.

If all of the irrigation water rights from Rapid Creek could be utilized for a municipal supply, the flow, as regulated by existing storage, would provide Rapid City with an adequate water supply until


104°
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B U T T E
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LAWRENCE
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WYOMING
SOUTH DAKOTA
P E N N I N G T O N
RAPID CITY
W E S T O N
C U S T E R
F A L L R I V E R
N I O B R A R A
Niobrara
LEGEND
OUTCROPS OF SEDIMENTARY ROCKS (PAHASAPA [MADISON] LIMESTONE AND MINNELUSA FORMATION) WHERE MAJOR WATER LOSSES OCCUR. LOSSES USUALLY OCCUR WHERE SOLUTION CHANNELS ARE EXPOSED IN THE STREAMBED OR THE FORMATIONS ARE PERMEABLE. WATER, THEN, IS LOST THROUGH DOWNWARD PENETRATION INTO THE FORMATIONS.
SALT LAKE CITY
RAPID CITY
DENVER
INDEX MAP
SCALE
25
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25 MILES

MAP 16. POTENTIAL MAJOR WATER LOSS AREAS

Table 49.—Potential reservoir sites

Stream	Location	Storage (acre-feet)	Surface area (acres)
Forest Service			
1. Calamity Peak	Sec.20,T.3S,R.5E.		140
2. Hazelrodt	Sec.10,T.4S,R.5E.		80
3. Wild Rose	Sec.8,T.3S,R.5E.		70
4. Redfern	Sec.29,T.1N,R.4E.		60
5. Elk Creek	Sec.24,T.4N,R.4E.		61
6. French Creek	Sec.28,T.3S,R.4E.		55
7. South Fork Rapid Creek	Sec.17,T.2N,R.3E.		39
8. Slate Creek	Sec.22,T.1N,R.4E.		30
9. Willow Creek	Secs.5&6,T.3S,R.5E		22
10. Buskala Creek	Sec.20,T.3N,R.3E.		25
11. Ward Draw	Sec.2,T.3N,R.2E.		25
12. Spring Creek	Sec.7,T.2S,R.4E.		26
13. South Boxelder Creek	Sec.25,T.3N,R.4E.		15
14. Cow Creek	Sec.1,T.52N,R.63W.		15
15. Iron Creek	Sec.33,T.2S,R.5E.		15
16. Grizzly Creek	Sec.19,T.2S,R.6E.		15
17. Togus Creek	Sec.33,T.53N,R.63W.		7
18. South Fork Castle Creek	Sec.10,T.1S,R.2E.		5
South Dakota Department of Game, Fish and Parks			
19. Spring Creek	Sec.14,T.1S,R.6E.		59
20. Middle Boxelder Creek	Sec.22,T.3N,R.4E.		30
21. South Boxelder Creek	Sec.30,T.3N,R.5E.		93
22. Elk Creek	Sec.24,T.4N,R.4E.		91
23. Slate Creek	Sec.3,T.1N,R.4E.		35
24. Spring Creek	Sec.2,T.2S,R.3E.		20
25. Tilson Creek	Sec.31,T.3N,R.3E.		42
26. Prairie Creek	Secs.21&22,T.1N,R.6E.		21
27. Beaver Creek	Sec.24,T.6S,R.6E.		71
Bureau of Reclamation			
28. Fourmile Creek 1/	Sec.1,T.6N,R.8E.	8,400	390
29. Indian Creek	Sec.11,T.10N,R.3E.	7,100	830

1/ Offstream reservoir, water supply from Belle Fourche River.

Table 49.—Potential reservoir sites (continued)

Stream	Location	Storage (acre-feet)	Surface area (acres)
Corps of Engineers			
30. Bear Butte Creek	Sec.13,T.5N,R.4E.	9,000	220
31. Deadman Creek	Sec.16,T.5N,R.5E.	3,700	65
32. Belle Fourche River	Secs.20&29,T.9N,R.1E.	300,000	6,450
33. Redwater River	Secs.4&9,T.7N,R.2E.	134,000	2,900
34. False Bottom Creek	Sec.25,T.6N,R.2E.	5,300	106
35. Cheyenne River	T.40N,R.61W.	600,000	12,000
36. Beaver Creek	Sec.32,T.6S,R.1E.	292,000	7,000
37. Rapid Creek	Sec.13,T.1N,R.6E.	14,750	162
38. Canyon I (Rapid Creek)	Sec.31,T.2N,R.7E.	Dry	--
38a. Canyon II (Rapid Creek)	Sec.32,T.2N,R.7E.	Dry	--
39. Boxelder Creek	Sec.24,T.2N,R.6E.	46,000	720
40. Cambria Creek	Sec.20,T.45N,R.61W.	6,000	94
41. Cheyenne River	Secs.33&34,T.6N, R.15E.	960,000	19,000
Soil Conservation Service			
42. Elk Creek	Secs.13&14,T.3N,R.6E.	4,118	150
43. Beaver Creek	Sec.31,T.6S,R.7E.	2,871	189
44. Cleghorn Canyon	Sec.7,T.1N,R.7E.	1,025	26
45. Line Creek	Sec.29,T.2N,R.7E.	572	37
46. South Canyon	Sec.32,T.2N,R.7E.	1,006	36
47. Cowboy Hill	Sec.34,T.2N,R.7E.	1,550	96
48. Trib. to Rapid Creek	Sec.10,T.1N,R.7E.	5,030	195
49. Vanocker Creek	Sec.15,T.5N,R.5E.	2,665	95
50. Battle Creek	Sec.35,T.3S,R.7E.	14,075	490
51. Battle Creek	Sec.19,T.3S,R.9E.	5,289	321
52. Middle Redwater Creek	Sec.20,T.52N,R.61W.	200	20
53. Trib. Little Mo. River	T.57N,R.65W.	250	30
54. Black Tail Creek	Sec.34,T.54N,R.64W.	75	10
55. Trib. Beaver Creek	Sec.9,T.52N,R.63W.	60	10
56. (Same as number 17)			
57. Inyan Kara Creek	Sec.16,T.49N,R.62W.	240	20
58. North Redwater Creek	Sec.17,T.53N.R.62W.	280	20
59. Inyan Kara Creek	Sec.3,T.50N,R.63W.	51	10
60. Foster Creek	Sec.8,T.56N,R.63W.	103	14
61. S. Redwater Creek	Sec.18,T.52N,R.61W.	209	24
62. Blacktail Creek	Sec.9,T.43N,R.61W.	265	26
63. Oil Creek	Sec.9,T.46N,R.62W.	10	2
64. Trib. Cheyenne River	Sec.20,T.41N,R.65W.	115	12
65. Trib. Cheyenne River	Sec.29,T.41N,R.65W.	19	5
66. Stockade Beaver	Sec.6,T.45N,R.60W.	112	12
67. Oil Creek	Sec.11,T.47N,R.62W.	243	17
68. Blacktail Canyon	Sec.15,T.46N,R.62W.	65	10

Table 49.—Potential reservoir sites (continued)

	Stream	Location	Storage (acre-feet)	Surface area (acres)
	Soil Conservation Service (continued)			
69.	Oil Creek	Sec.3,T.47N,R.62W.	25	5
70.	Skull Creek	Sec.31,T.48N,R.62W.	86	22
71.	Raven Creek	Sec.3,T.47N,R.68W.	90	10
72.	Raven Creek	Sec.27,T.47N,R.68W.	74	10
73.	Alkali Creek	Sec.10,T.41N,R.63W.	112	25
74.	Lodgepole Creek	Sec.22,T.43N,R.65W.	46	20
75.	Musk Creek	Sec.8,T.43N,R.63W.	25	6
76.	Buffalo Creek	Sec.8,T.48N,R.67W.	68	10
77.	Lance Creek	Sec.15,T.33N,R.66W.	118	13
78.	Old Woman Creek	Sec.27,T.35N,R.63W.	29	4
79.	Old Woman Creek	Sec.16,T.35N,R.62W.	31	6
80.	Trib. Cheyenne River	Sec.5,T.40N,R.62W.	35	6
81.	Wildcat Creek	Sec.1,T.40N,R.62W.	21	3

Other

82. Numerous small reservoirs (less than five acres of surface area) and other water development structures are planned for by the Bureau of Land Management, Forest Service, and Soil Conservation Service. Plans for development and tentative locations may be checked by inquiring at the appropriate field offices.

the year 2010. This would not prevent irrigation below Rapid City since, with proper waste treatment, city outflow could be used for irrigation.

Agricultural Practices

The Soil Conservation Service has received five applications for watershed management planning assistance under the Watershed Protection and Flood Prevention Act (P.L. 566). They are on Inyan Kara Creek (220,300 acres), Arch Creek (66,368 acres), and Cabin Creek (32,283 acres) watersheds in Wyoming; and on Rapid Creek (153,462 acres) and Bear Butte Creek (144,000 acres) watersheds in South Dakota. Investigations made by the Department of Agriculture indicate that there is potential for 10 to 20 additional project developments under P.L. 566, and for a Resource Conservation and Development Project under the Food and Agriculture Act, P.L. 87-703. Over 300,000 acres is subject to flooding and more than a million acres has water erosion problems.

Irrigation practices.--Some private irrigation projects can be improved by suitable drainage installations to lower the high water table and rehabilitate "salted" areas. Irrigation capabilities can also be increased by consolidation of small individual irrigation projects. Losses can be substantially decreased with improved water storage and conveyance facilities and irrigation practices.

Studies indicate on-the-farm deep percolation losses and surface wastes of irrigation water may approach 50 percent of the water applied to the fields on many irrigated farms. This represents a substantial loss of water and also causes excessive leaching of plant nutrients from the soil. Improvement of on-the-farm irrigation facilities, field layouts, and irrigation practices could increase irrigation efficiency and thus save substantial amounts of water.

Evaporation from the principal impoundments in the area is estimated to exceed 30,000 acre-feet per year. Monomolecular films, such as hexadecanol and octadecanol alcohols, have shown promise in reducing evaporation. Although this method is expensive at present, further study may reduce costs substantially.

Improved means and facilities for water measurement would enable more equitable diversion and beneficial use of the water. The use of watermasters, for example, would prevent unauthorized use.

Water Quality Control

New treatment processes to reduce the salinity of water are now available. Costs are quite high but they are being reduced and within the next decade the processes may become economically feasible.

Weather Modification

Studies conducted in the past indicate that storms influenced by orographic features such as the Black Hills can be induced to produce more precipitation than usual with artificial nucleation. The Institute of Atmospheric Science, South Dakota School of Mines and Technology at Rapid City, is currently conducting an extensive program of research into cloud and precipitation processes in the northern Great Plains for the Bureau of Reclamation. The areas under study at the present time are immediately east of the Black Hills near Rapid City and near Lemmon, South Dakota. The ultimate objective of this research program is the development of means of increasing precipitation from the cumuliform clouds characteristic of the spring and summer seasons.

Improved Water Yields

One of the most promising ways for increasing the water supply from forested watersheds is through manipulation of the vegetative type. Riparian cutting of wetside vegetation and block and strip cutting of timber stands have increased water yield.

Studies indicate that vegetative treatment to increase water yield would have to be rather severe because precipitation in the Black Hills occurs mostly in the growing season. Regular silvicultural thinning in the ponderosa pine is not likely to result in increased streamflow except in extremely wet years.

Research is needed to determine where the greatest increases in water yield can be expected per dollar expended for vegetative manipulation with the least adverse affect on wood fiber production and recreation.

Multiple Use

Water is an essential element in the use and management of other renewable resources of the Black Hills. Demand for water far exceeds supply, and will continue to do so. Careful consideration will be necessary in the allocation and use of water in order to achieve optimum harmonious and coordinated management with other resources. This is the key to successful multiple use.

Conclusions

Water is one of the most important natural resources in the Black Hills, possibly the most important. It is vital to any further development in the area and yet the basic hydrologic knowledge upon which comprehensive water development programs must be based is not available. It is possible to plug the sinkholes in the Minnelusa limestone yet such an action might have a damaging effect on the total water supply. Even the basic facts regarding the total surface water production capability of the area are only generally known. The following studies in this field are specifically recommended:

1. An intensive hydrologic study should be made of a selected tributary-drainage basin in the Black Hills. This study would include instrumentation to determine evaporation from streams and impoundments and transpiration by trees and plants, as well as streamflow, sinkhole losses, and ground-water movement. The study would provide basic data that would be invaluable for planning purposes in the Black Hills area and throughout much of the Rocky Mountain uplift.

2. Stream-gaging and precipitation stations should be installed on all major tributaries to determine water yields from the central crystalline rock area of the Black Hills. Additional stream-gaging stations also should be installed on selected streams to determine water gains and losses.

3. Investigations should be made to determine the quantity and quality of water available in counties within the area adjacent to the Black Hills and to determine the hydrologic characteristics of the deep aquifers which underlie the counties.

4. All potential reservoir sites should be investigated and reservoirs built where feasible, if investigation shows that water supplies

are available and a multipurpose need will be served by the storage and control facility.

5. Research in weather modification should be continued. Knowledge gained and techniques evolved could have a far-reaching effect on the economy of the northern Great Plains as well as the Black Hills area by increasing the water supply and reducing damage from lightning, fires, and hail.

6. A comprehensive program of water pollution control should be developed and implemented through the cooperative efforts of local, State, and Federal agencies to assure satisfactory water quality for all present and future legitimate water uses.

7. Research should be accelerated to determine feasible methods of manipulating vegetative cover to increase water yield.

8. Action should be initiated to implement the planning and application of watershed project opportunities with maximum consideration for multiple use of water. This can be done under existing authorities.

9. A program should be initiated which would result in consolidation of existing small irrigation projects and improved efficiencies of water use.